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Volume 2

Appendix A – Inspection Schedule

Appendix B – Report on the Condition Assessment of Concrete Decks with Respect to Delamination on Wilmington Viaduct in Delaware

Appendix C – Appendix to Report on the Condition Assessment of Concrete Decks with Respect to Delamination on Wilmington Viaduct in Delaware

Appendix D – Coring Reports

Appendix E – Petrography Examination Report

Appendix F – Paint Adhesion Results

Appendix G – BR 1-744 Underwater Inspection Report

Volume 3

Appendix H – Field Notes

1.0 Executive Summary

In accordance with our approved October 21, 2014 scope of services document, the Whitman, Requardt & Associates, LLP (WRA) team has prepared this Design Level Inspection Report to present our findings (with repair recommendations and conceptual costs) resulting from the recently completed design level inspection and testing of the specified project bridges, which include the following:

- 1-748 – I-95 Mainline Wilmington Viaduct (southern section)
- 1-748N – I-95 NB Mainline Wilmington Viaduct (northern section)
- 1-748S – I-95 SB Mainline Wilmington Viaduct (northern section)
- 1-749 – I-95 NB Ramp to SR 4 (Ramp A)
- 1-750 – SR 48 Ramp to I-95 SB (Ramp B)
- 1-758 – SR 48 Ramp to I-95 SB (Ramp C)
- 1-758E – Martin Luther King Jr. Boulevard Ramp to I-95 NB (Ramp E)
- 1-758F – Martin Luther King Jr. Boulevard Ramp to I-95 SB (Ramp F)
- 1-758G – Martin Luther King Jr. Boulevard Ramp to I-95 SB (Ramp F)
- 1-758H – Martin Luther King Jr. Boulevard Ramp to I-95 (Ramp E/F)
- 1-744 – I-95 over Christina River
- 1-745 – I-95 over Norfolk Southern Railroad
- 1-746 – I-95 over Little Mill Creek

This Design Level Inspection Report is comprised of three (3) volumes to facilitate easier review and use of the large amount of data collected, presented, and evaluated. Volume 1 contains a summary of the design level inspection and testing findings including repair recommendations and costs. Volume 1 has been formatted to present the results of the completed inspection and testing including repair defects and recommendations by bridge. Thus each project bridge has its own discrete section within the report and results are presented consistently using an identical outline. The Volume 2 appendices contain results of the nondestructive evaluation (NDE), concrete coring reports, petrography reports, paint adhesion results, and BR 1-744 underwater inspection report. Volume 3 contains all of the various field data forms and field notes. Reference the table of contents for further information.

This report includes this executive summary, and for each project bridge, a bridge description, location map, summary of the NDE program, concrete coring plan with core and petrographic results, paint adhesion results, summary of findings, photo documentation of typical defects, and an itemized listing of documented defects. An overall summary of repair recommendations with a conceptual cost estimate is presented at the end of this report.

The design level inspection began during the week of November 17, 2014 and concluded on February 5, 2015. Note that due to fracture critical cross girder confined space access issues at Bridge 1-745, additional field inspection days on February 23 and 24, 2015 were utilized to complete the design level inspection work. An inspection schedule for all of the project bridges can be found in Section 3.0 of this report and in Appendix A of Volume 2.

The Wilmington Viaduct bridges, 1-748, 1-748N, and 1-748S, comprise the mainline elevated section of I-95 in downtown Wilmington, Delaware. Composed entirely of single span steel beam and girder units, the overall length of the viaduct is approximately 5,462' measured from centerline of abutment bearings. The mainline bridges, along with bridges 1-744, 1-745, 1-746, and ramps 1-749, 1-750, and 1-758 were originally built in 1964. In 1978, Bridges 1-744, 1-745, 1-746, and 1-748 were widened and ramps 1-758E, 1-758F, 1-758G, and 1-758H were constructed. The typical superstructure construction consists of a reinforced concrete deck supported by steel rolled beams (or steel built-up girders) and reinforced concrete multi-column piers. Note that Spans 10-26 of BR 1-748 consists of built-up steel plate girders supported by fracture critical steel cross girders on reinforced concrete columns. The decks of the mainline bridges and ramps (1-749, 1-750, and 1-758) are typically protected by a varying thickness LMC overlay.

The bridges have been rehabilitated in 2000 and 2004 to address bearing and joint deficiencies, install seismic retrofits, reconstruct the concrete parapets, and affect miscellaneous maintenance repairs to extend the useful service life of each project bridge.

Ultimately, it is the goal of the Department to effectively extend the useful service life of each project bridge in order to avoid any major rehabilitation work for 30 years. In addition, given the high volume of traffic that uses I-95 daily, and the adverse impacts lane reductions will have on this roadway and the local City streets, it is imperative that the rehabilitation work completed under the proposed construction will address all maintenance and service life issues. Overall, the project bridges are in satisfactory condition at this time as no significant defects were documented that would adversely affect the structural capacity of the bridges. Typical defects observed include debonding of the LMC deck overlay, failing/leaking deck joints, spalling and cracking of the substandard bridge parapets, clogged and/or damaged drainage devices, peeling paint and light corrosion at the beam ends, corroded and misaligned bearings, and minor concrete spalling and cracking of the substructure.

The results of the NDE and testing program indicate that the LMC overlay has served its purpose of protecting the base structural deck. While the overlay is beginning to debond with the deck and random delaminations have resulted within the bridge decks themselves, it appears that the condition has not progressed to a point that would require major reconstruction at this time. However, results of the NDE indicate that additional deck delamination may initiate within the next five (5) years as it appears the LMC overlay has reached its effective service life.

Three (3) types of recommendations have been developed for the project bridges: monitoring, repair, and design recommendations. Because of the long term uncertainty of the scope and extent of required repairs, and the potential for delayed construction due to other project schedules in the vicinity, monitoring of the deck condition is recommended and includes additional NDE and testing. Recommended repairs include constructing a new LMC deck overlay, installing new strip seal deck joints in conjunction with eliminating existing deck joints located at adjacent fixed bearings by placing a deck continuity pour, cleaning and painting the entire superstructure including bearings, repairing the scupper and drainage system, and repairing substructure concrete spalling and cracking. Design recommendations include reconstructing all existing parapets to meet the new test level 5 (TL-5) F-shape bridge parapet configuration and replacing the concrete decks on BR 1-749, 1-750, 1-758, 1-758E, 1-758F, and 1-758G. Given the narrow clear roadway widths available on each of these ramp bridges, the parapets can be reconstructed more efficiently during a full ramp closure. Furthermore, since the remaining limits of the deck associated with the parapet reconstruction are relatively narrow, that portion of the deck can be replaced as well during the ramp closure period without significant impact to the overall construction duration or cost.

2.0 Manpower

The design level inspection was performed by the WRA team and consisted of inspection team members from WRA, Pennoni Associates, Inc. (PAI), and RJM Engineering, Inc. (RJM). In addition, non-destructive evaluation (NDE) was performed on the deck by Transportation Infrastructure Systems, Inc. (TIS).

Typical daily manpower consisted of three (3) inspection teams during the day. Night time NDE was performed on the deck which typically consisted of three inspection teams. Lane closures were provided by Enterprise Flasher Company and flagging was provided by Amtrak and Norfolk Southern Railroad.

2.1 Design Level Inspection Staff

The design level inspection was performed by the following inspectors from the WRA team:

Kelly L. Ambrose – ATL	Brett Marshall – ATL
Susan E. Bowers, P.E. – TL	Larry Murphy – Audit QA/QC
Houston Brown, P.E. – ATL	David A. Nizamoff, P.E. - TL
Nathan W. Buttorff, P.E. – TL	Fred J. Ophardt, P.E. – TL
Lauren Clark – ATL	Timothy J. Porter – ATL
Daniel Clem – ATL	Hanlin Qin, P.E. - TL
Anthony D. DiLoreto, P.E. – TL	James R. Quigley, P.E. – TL
Zachary M. Gabay, P.E. – ATL	Michael Rakowski, P.E. – TL
William A. Geschrei, P.E. – Audit QA/QC	Joe Spadea, P.E. – TL
Cynthia Z. Katcoff – ATL	Jack G. Verhoeven, P.E. – ATL
Chance W. Malkin – ATL	Kai Yi, P.E. - ATL

Legend: TL = Team Leader; ATL = Assistant Team Leader

2.2 Testing Staff

The NDE testing was performed by the following inspectors and technicians from the WRA team and our subcontractor TIS:

Thomas Bator – Inspector	Jinyoung Kim – NDE Operator
Madeline Carr – Inspector	Richard Lawrie – Inspector
Joe Challburg - Inspector	Ken Lee – NDE Operator
Ben Crabill – Inspector	Marko Lyszyk – NDE Operator
Leon Hosier – Paint Testing	Jesse Maisch – Core Driller
Insung Hwang – NDE Operator	Shane Mott – NDE Operator
Emre Imamoglu – NDE Operator	Joe Odorisio – Core Driller
Heather Jones – Inspector	Xiaoyang Wu – NDE Operator

3.0 Inspection Schedule

The design level inspection of the specified project bridges was substantially completed between November 16, 2014 and February 5, 2015. Issues with access during the inspection of the underside of Bridge 1-745 over Norfolk Southern resulted in the need for two additional days of inspection, which were completed February 24 and 25, 2015. Due to observed deficiencies in the reinforced concrete abutments of Bridges 1-758F and 1-758G, inspection and testing crews were on site on March 2, 2015 to obtain concrete core samples from each abutment. See Appendix A for weekly inspection schedules summarizing work completed at each structure throughout this timeline.

3.1 Inspection Access

A variety of different equipment was used to access the specified project bridges in order to complete the design level inspection. When needed the maintenance of traffic for the inspections was provided by Enterprise Flasher Company on I-95 and City streets.

BR 1-748, BR 1-748N, and BR 1-748S: 45', 60', and 80' manlifts were used to access the viaduct bridges as well as a 24' ladder and lift van. The steel transverse box girder pier caps required a confined space inspection and use of an air meter. Inspection over Amtrak tracks was performed at night using the Amtrak Catenary Car and coordination with Amtrak personnel to de-energize the tracks. MOT required to perform the underside inspection included flagging along Delmarva Lane and Beech Street and lane closures along Maryland Avenue and Lancaster Avenue.

BR 1-749: A 45' manlift was used to access BR 1-749.

BR 1-750: A 24' ladder and 45' manlift were used to inspect BR 1-750. MOT required to perform the underside inspection included lane closures along Lancaster Avenue.

BR 1-758: A 24' ladder, 45' manlift, and a lift van were used to inspect BR 1-758. MOT required to perform the underside inspection included lane closures along Maryland Avenue.

BR 1-758E: A 45' and 60' manlift were used to inspect BR 1-758E. MOT required to perform the underside inspection included lane closures along Adams Street.

BR 1-758F: A 45' and 60' manlift as well as a 24' ladder were used to inspect BR 1-758F. MOT required to perform the underside inspection included lane closures along Lancaster Avenue and Adams Street.

BR 1-758G: A 24' ladder, 45' manlift, and a lift van were used to inspect BR 1-758G. MOT required to perform the underside inspection included lane closures along Maryland Avenue.

BR 1-758H: A 45' manlift and a lift van were used to inspect BR 1-758H. MOT required to perform the underside inspection included lane closures along Monroe Street and N. Madison Street.

BR 1-744: A 36' manlift placed on a barge was used to inspect BR 1-744.

BR 1-745: Two (2) 45' manlifts were used to inspect BR 1-745. Norfolk Southern flagging was required. The inspection of the steel piers caps at BR 1-745 required a confined space inspection and use of a gas meter. A DelDOT maintenance crew assisted in removing the bolted access grates. Grates were put back in place at the time of inspection, but were not bolted back down to facilitate access for the subsequent biennial inspection of this bridge

BR 1-746: A 60' snooper and waders were used to inspect BR 1-746. The lane closures required to access the bridge via snooper were performed during a nighttime lane closure.

Nighttime lane closures and MOT provided by Enterprise Flasher Company were used to perform the topside inspection, NDE, and concrete coring for the project bridges.

A 37' bucket truck was used for audit inspections of the bridges.

3.2 Inspection Limits

The design level inspection of the specified project bridges did not include inspection of the barriers along BR 1-748, BR 1-748N, BR 1-748S, BR 1-744, BR 1-745, and BR 1-746 since these barriers do not meet current standards and are being replaced. Barriers were inspected on all of the ramp bridges, however. In order to replace the barriers, the overhang and a portion of the outside bays is being removed and replaced. Therefore, these areas were not inspected on BR 1-748, BR 1-748N, BR 1-748S, BR 1-744, BR 1-745, and BR 1-746. Lighting was also not inspected as it is anticipated to be replaced as part of the bridge rehabilitation project.

4.0 Findings

The results of the design level inspection and associated testing are presented in detail in this section of the report. A dedicated subsection is provided for each project bridge and includes a bridge description, location map, summary of the NDE program, concrete coring plan with core and petrographic results, paint adhesion results, summary of findings, representative photos of each defect (or any unique defects), and a tabulated list of defects itemized by deck, superstructure, and substructure. In addition, defects are identified by span number or substructure unit number as appropriate.

Typical findings (i.e., defects) include:

Deck:

- Delaminations and spalls in the concrete overlay.
- Deck joints typically exhibit depressed or torn material and are leaking.

Superstructure:

- Beams exhibit random locations of peeling and flaking paint with corrosion at the beam ends.
- Several bearings exhibit pack rust between the plates.

Substructure:

- The steel pier caps typically exhibit flaking paint and minor rust.
- The concrete abutments and piers exhibit cracks, areas of delaminated concrete, and spalls with exposed corroded reinforcement.

4.1 Wilmington Viaduct (Bridges 1-748, 1-748N, and 1-748S)

4.1.1 Bridge Description

The Wilmington Viaduct consists of Bridges 1-748, 1-748N, and 1-748S and comprises the mainline elevated section of I-95 in downtown Wilmington, Delaware over Amtrak and various City streets. The entire structure is a sixty (60) span steel beam bridge composed entirely of single span units built in 1964 and widened in 1978. Rehabilitation was performed on the viaduct in 2000 that included bearing replacements, seismic retrofits, strip seal replacements, parapet rehabilitation, substructure repairs, drainage repairs, and painting. The viaduct has an overall length of 5462'-0"± measured from centerline of abutment bearings.

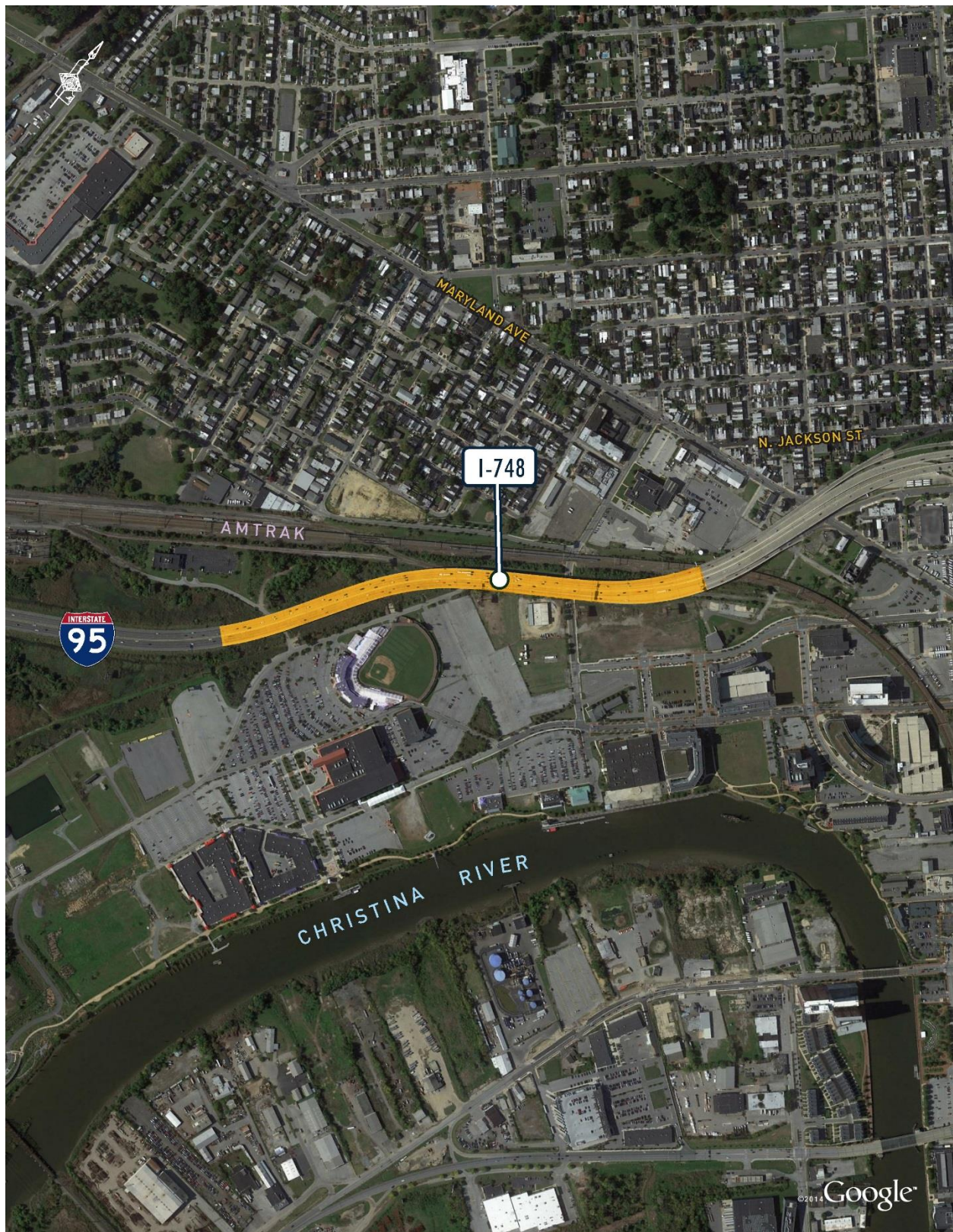
Bridge 1-748 is the mainline viaduct carrying I-95 through the City of Wilmington, Delaware (see Location Map in Section 4.1.2). BR 1-748 is the southern section of the viaduct. The structure is a twenty six (26) span simply supported steel girder bridge built in 1962 and widened in 1978. The bridge has an overall length of 2934'-0"± measured from centerline of bearings with span lengths of 6 @ 118'-0"±, 3 @ 116'-0"±, 149'-0"±, 138'-0"±, 141'-0"±, 5 @ 89'-0"±, 96'-0"±, 2 @ 89'-0"±, 96'-0"±, 2 @ 138'-0"±, 137'-0"±, 115'-0"±, and 107'-0"±. The bridge has an out-to-out width of 111'-1"± providing a clear roadway width of 52'-4½"± in each direction. The bridge carries six (6) lanes of traffic on I-95, three (3) lanes each in the northbound and southbound directions. The superstructure in Spans 1 – 18 consists of sixteen (16) painted steel plate girders. The superstructure in Spans 19 and 20 consists of seventeen (17) painted steel plate girders. The superstructure in Span 21 consists of eighteen (18) painted steel plate girders. The superstructure in Span 22 consists of nineteen (19) painted steel plate girders. The superstructure in Spans 23 and 24 consists of twenty one (21) painted steel plate girders. The superstructure in Spans 25 and 26 consists of seventeen (17) painted steel plate girders. The superstructure supports a 7½"± thick reinforced concrete deck on the original structure built in 1962 and an 8" thick reinforced concrete deck on the widened structure built in 1978. According to plans, the existing deck on the original structure built in 1962 is protected by a 2½"± thick LMC overlay and the existing deck on the widened structure built in 1978 is protected by a 1¼"± thick LMC overlay. Both the median and outside barriers are 2'-8"± high jersey shape reinforced concrete parapets. The substructure consists of reinforced concrete columns with reinforced concrete pier caps at Piers 1 – 9, reinforced concrete columns with painted steel transverse box girders at Piers 10 – 12 and Piers 20 – 26, reinforced concrete columns with painted steel transverse plate girders at Piers 13 – 19, and a reinforced concrete stub abutment at the south end of the bridge. The steel transverse box girders are considered fracture critical and require a confined space inspection. The structure shares a pier with BR 1-748N, BR 1-748S, and BR 1-758G at the north end and also shares Pier 24 with BR 1-749.

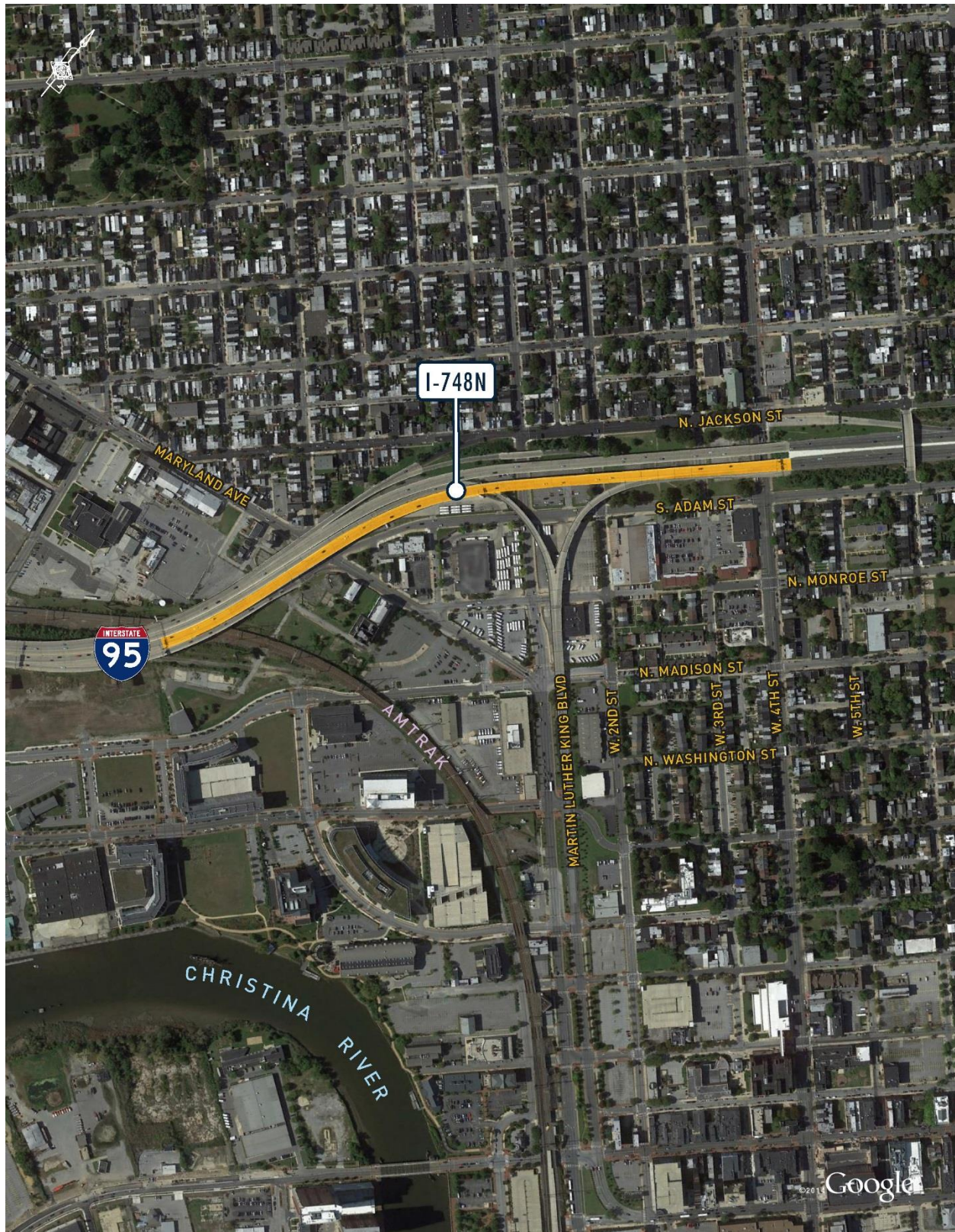
Bridge 1-748N is the mainline viaduct carrying NB I-95 through the city of Wilmington, Delaware (see Location Map in Section 4.1.2). BR 1-748N is the northern northbound section of the viaduct. The structure is a thirty four (34) span simply supported steel beam bridge built in 1964. The bridge has an overall length of 2528'-0"± measured from centerline of bearings with span lengths of 73'-0"±, 5 @ 74'-0"±, 137'-6½"±, 64'-5½"±, 2 @ 68'-0"±, 70'-0"±, 7 @ 68'-0"±, 71'-0"±, 80'-0"±, 3 @ 75'-0"±, 79'-0"±, 5 @ 70'-0"±, 3 @ 82'-0"±, 93'-0"±, and 57'-0"±. Note, span numbering continues in sequence from the end of BR 1-748. The bridge has an out-to-out width of 42'-2"± providing a clear roadway width of 37'-9"±. The bridge carries two (2) lanes of traffic on NB I-95. The superstructure in Spans 27 – 32 and Spans 34 – 53 consists of six (6) painted steel rolled beams with welded cover plates supporting a 7½"± thick reinforced concrete deck. The superstructure in Span 33 consists of six (6) painted steel plate girders supporting a 7½"± thick reinforced concrete deck. The superstructure in Spans 54 and 55 consists of seven (7) painted steel rolled beams with welded cover plates supporting a 7½"± thick reinforced concrete deck. The superstructure in Spans 56 and 57 consists of eight (8) painted steel rolled beams with welded cover plates supporting a 7½"± thick reinforced concrete deck. The superstructure in Span 58 consists of nine (9) painted steel rolled beams supporting a 7½"± thick reinforced concrete deck. The superstructure in Spans 59 and 60 consists of ten (10) painted steel rolled beams with welded cover plates supporting a 7½"± thick reinforced concrete deck. According to the plans, the existing deck is protected by a 2¼"± thick LMC overlay. Both the outside barriers are 2'-8"± high jersey shape reinforced concrete parapets. The substructure consists of reinforced concrete columns with reinforced concrete pier caps and a reinforced concrete stub abutment at the north end of the bridge. The structure shares a pier with BR1-748 at the south end.

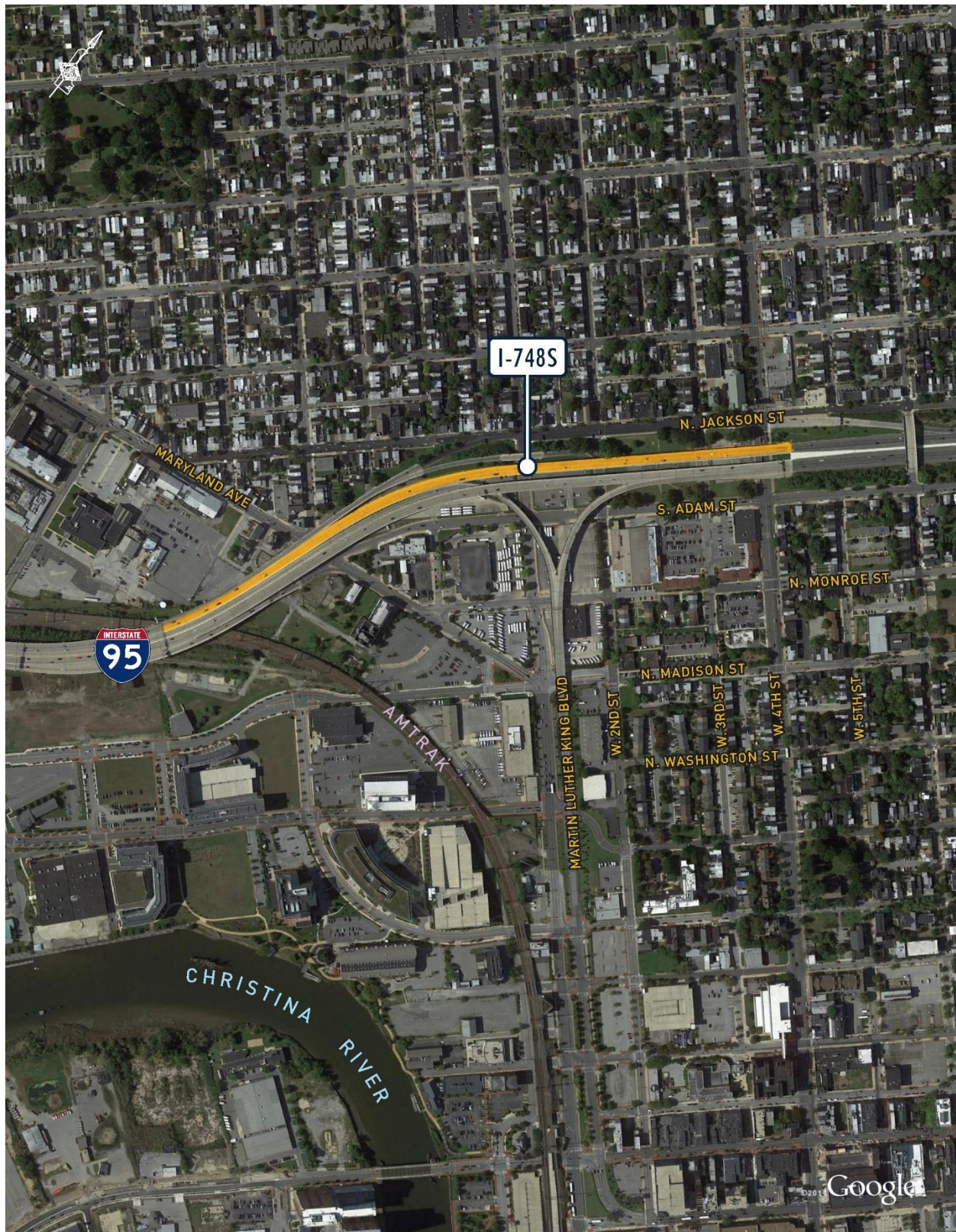
Bridge 1-748S is the mainline viaduct carrying SB I-95 through the city of Wilmington, Delaware (see Location Map in Section 4.1.2). BR 1-748S is the northern southbound section of the viaduct. The structure is a thirty four (34) span simply supported steel beam bridge built in 1964. The bridge has an overall length of 2528'-0"± measured from centerline of bearings with span lengths of 73'-0"±, 5 @ 74'-0"±, 137'-6½"±, 64'-5½"±, 2 @ 68'-0"±, 70'-0"±, 7 @ 68'-0"±, 71'-0"±, 80'-0"±, 2 @ 75'-0"±, 60'-0"±, 94'-0"±, 5 @ 70'-0"±, 3 @ 82'-0"±, 93'-0"±, and 57'-0"±. Note, span numbering continues in sequence from the end of BR 1-748. The bridge has an out-to-out width of 42'-2"± providing a clear roadway width of 37'-9"±. The bridge carries two (2) lanes of traffic on SB I-95. The superstructure in Spans 27 - 29 consist of seven (7) painted steel rolled beams with welded cover plates supporting a 7½"± thick reinforced concrete deck. The superstructure in Spans 30 – 31 consists of eight (8) painted steel rolled beams with welded cover plates supporting a 7½"± thick reinforced concrete deck. Span 32 consists of nine (9) painted steel rolled beams with welded cover plates supporting a 7½"± thick reinforced concrete deck. Span 33 consists of nine (9) painted steel plate girders supporting a 7½"± thick reinforced concrete deck. Spans 34 – 60 consist of six (6) painted steel rolled beams with welded cover plates supporting a 7½"± thick reinforced concrete deck. According to the plans, the existing deck is protected by a 2¼"± thick LMC overlay. Both the outside barriers are 2'-8"± high jersey shape reinforced concrete parapets. The substructure consists of reinforced concrete columns with reinforced concrete pier caps and a reinforced concrete stub abutment at the north end of the bridge. The structure shares a pier with BR1-748 at the south end and shares Pier 33 with BR 1-758.

Note, the numbering convention used in this report follows the numbering convention used in the biennial inspection reports where the first span is numbered 1. This differs from the plans where the first span is numbered 0.

4.1.2 Location Map







4.1.3 NDE Plan

The bridge deck was surveyed using NDE methods in order to completely assess the condition of the original structural concrete deck and the LMC overlay. The goal of the NDE program was to determine the condition of the LMC overlay and whether it had adequate bond to protect the deck, note the presence and location of delaminations in the structural concrete deck, and provide assistance to approximate the probable quantity of structural concrete deck repairs that would be required following removal (i.e., milling) of the LMC overlay. The assessment was conducted using the Impact Echo (IE) methodology in order to determine the location and severity of observed debonding between the base structural concrete deck and the LMC overlay, and delaminations within the base structural deck. A 2' long x 2' wide grid was laid out on the bridge deck in between the shoulder lines using water soluble paint. Since the Department directed the team to forego inspection of the bridge parapets and adjacent shoulders (see Section 3.1), IE test readings were therefore taken only within the travel lanes.

Bridge 1-748: In the southbound direction, the left, middle, and right lanes in Spans 1 through 24, and left and middle lanes in Spans 25 and 26 were surveyed. In the northbound direction, the left, middle, and right lanes in Spans 1-26 were surveyed. Throughout the northbound and southbound lanes, a total of 26 spans, or 154 "span-lanes" were tested.

Bridge 1-748N: The left and right lanes in Spans 27 through 51, and the left, middle and right lanes in Spans 52 through 60 were surveyed. A total of 34 spans, or 77 "span-lanes" were tested.

Bridge 1-748S: The left and right lanes in Spans 27 through 60 were surveyed. A total of 34 spans, or 68 "span-lanes" were tested.

4.1.3.1 NDE Results

The following is a summary of the NDE results. Delaminations are defined as predominately horizontal cracks found in the base structural deck, while debonding is defined as a separation or loss of bond between the base structural deck and the LMC overlay. Results are presented with an IE deck condition rating from 0 to 100 (these are relative condition ratings with respect to each project bridge and cannot be compared to any other bridges) and an overall IE deck condition state of Good, Fair, Poor, or Serious, quantified by deck area percentage (%). Good (or "sound") is defined by the lack of delaminations within the base structural deck. Fair is defined as the potential presence of initial delamination described as occasional (local) separations within the deck. Poor is defined as the presence of a continuous delamination of a smaller width, relative to the depth, or thickness, of the deck. In many cases, it cannot be detected by chain drag or hammer sounding as it is often outside the audible range given the delamination is located deeper within the deck between the top and bottom mats of reinforcing steel. Serious is defined as a continuous delamination of a larger width, relative to the depth and is a result of flexural oscillations of the delaminated part of the deck. It is in the audible range. Areas of the deck in serious condition can be detected by chain drag or hammer sounding given the delamination is located at or near the top mat of reinforcing steel. Note that the IE deck condition states do not correlate with the NBI visual condition state ratings of 7, 5, 4, or 3, respectively. For further information and complete results, please reference the full NDE report in Appendices B and C.

Bridge 1-748: This bridge has an overlay thickness varying between 1" and 3". Coring results indicate the southbound left lane overlay thickness varies between 1.25" to 1.5", while the southbound middle and right lane overlay thickness varies between 2" and 3". Similarly, the northbound left lane overlay thickness is up to 1.5", while the northbound middle and right lane overlay thickness is greater than 2". On average, 58% of the deck area shows no signs of delamination. Approximately 31% is in a state of incipient delamination, which can be described as a state where there are signs of a discontinuous delamination (the deck has intermittent cracking, but is mostly connected). 10% of the deck area is in serious condition. For an overlay of 2" to 3", it is expected that the serious condition represents debonding of the overlay. However, it is possible that the debonding is underlain by delamination. For a thin overlay (less than 2"), the serious condition is more likely an indication of delamination in the structural deck. There are no significant differences in the deck condition between the southbound and northbound bridges. The deck area of both

bridges in the left lanes is in the best condition, with almost half of the spans with less than 5% of the deck area in serious condition. There are only three (3) spans in the right lanes where the condition rating is 60 or below. Those spans have close to 30% of the deck area in serious condition. The rest of the deck area is in a fair condition with condition ratings between 70 and 90. The majority of delaminations are along the joints. Overall, the condition of the deck is fair.

Bridge 1-748N: This bridge has an overlay thickness varying between 2" and 3". On average, 45% of the deck area shows no signs of delamination. Approximately 43% is in a state of incipient delamination, which can be described as a state where there are signs of a discontinuous delamination (the deck has intermittent cracking, but is mostly connected). 11% of the deck area is in serious condition. For an overlay of 2" to 3", it is expected that the serious condition represents debonding of the overlay. However, it is possible that the debonding is underlain by delamination. There are no significant differences in the deck condition between the two lanes, or between the spans. There are only a few "span-lane" areas where the percentage of the deck area in the serious condition approaches 20%. The majority of debonding/delaminations are along the joints. Overall the condition of the deck is fair to poor.

Bridge 1-748S: This bridge has an overlay thickness varying between 1.5" and 2.25". On average, 46% of the deck area shows no signs of delamination. Approximately 41% is in a state of incipient delamination, which can be described as a state where there are signs of a discontinuous delamination (the deck has intermittent cracking, but is mostly connected). 12% of the deck area is in the serious condition. For an overlay thickness of 1.5" to 2.25", it is expected that there is an equal possibility that the serious condition is a result of either debonding of the overlay or delamination of the structural deck. There are no significant differences in the deck condition of the two lanes, or between the spans. There are only six "span-lane" areas where the percentage of the deck area in the serious condition is 20% or more. The majority of delaminations are along the joints. Overall, the condition of the deck is fair..

4.1.4 Concrete Coring Plan

Bridge 1-748: A total of twenty-two (22) 3.25" diameter concrete core samples, 6" to 8" long, were extracted and laboratory tested in accordance with ASTM C42. Compressive strength testing was performed on the structural layers of the deck only, excluding any portion of the LMC overlay in accordance with ASTM C39. Fourteen (14) cores were tested for compressive strength, four (4) of which were additionally tested for water soluble chloride ions in accordance with ASTM C1218. Eight (8) cores were sent to Highbridge Materials Consulting, Inc. for petrographic examination and air-void analysis in accordance with ASTM C856 and ASTM C457, respectively. Fourteen (14) 3" diameter core holes were drilled through the overlay and pull testing was performed in accordance with ASTM C1583.

Bridge 1-748N: A total of nine (9) 3.25" diameter concrete core samples, 6" to 8" long, were extracted and laboratory tested in accordance with ASTM C42. Compressive strength testing was performed on the structural layers of the deck only, excluding any portion of the LMC overlay in accordance with ASTM C39. Six (6) cores were tested for compressive strength, two (2) of which were additionally tested for water soluble chloride ions in accordance with ASTM C1218. Three (3) cores were sent to Highbridge Materials Consulting, Inc. for petrographic examination and air-void analysis in accordance with ASTM C856 and ASTM C457, respectively. Six (6) 3" diameter core holes were drilled through the overlay and pull testing was performed in accordance with ASTM C1583.

Bridge 1-748S: A total of nine (9) 3.25" diameter concrete core samples, 6" to 8.5" long, were extracted and laboratory tested in accordance with ASTM C42. Compressive strength testing was performed on the structural layers of the deck only, excluding any portion of the LMC overlay in accordance with ASTM C39. Six (6) cores were tested for compressive strength, two (2) of which were additionally tested for water soluble chloride ions in accordance with ASTM C1218. Three (3) cores were sent to Highbridge Materials Consulting, Inc. for petrographic examination and air-void analysis in accordance with ASTM C856 and ASTM C457, respectively. Six (6) 3" diameter core holes were drilled through the overlay and pull testing was performed in accordance with ASTM C1583.

4.1.4.1 Concrete Core Results

The following is a summary of the concrete coring results; for further information, please reference the full report in Appendix D.

Bridge 1-748: The design strength of the concrete deck is 3000 psi. The tested cores resulted in an average compressive strength of 6060 psi, with a range of 3800 psi to 8070 psi.

Three (3) depth results in the base structural deck (0.5", 1", and 2") were obtained from each water soluble chloride ion core sample. The top layer of steel is located at 1.5" according to the plans. The maximum chloride content is 0.52 lbs./c.y. at the 0.5" depth (Sample 748SB-2C), 0.21 lbs./c.y. at the 1" depth (Sample 748SB-6C), and 0.08 lbs./c.y. at the 2" depth (Sample 748SB-2C). In accordance with DelDOT's Bridge Design Manual May 2005 Figure 9-1, a level of chloride contamination from 0 to 1.3 is considered low, 1.3 to 2.0 is considered moderate, and greater than 2.0 is considered advanced. Therefore chloride contamination in the upper and lower layers is considered low. The slightly higher concentration at the top of the structural slab in sample 748SB-2C may be due to the minimal overlay thickness of 1" at this location.

Failure of the pull test had a large variability, ranging between 14 psi to 283 psi, with the failure plane noted between the overlay wearing surface and the structural slab bond line. 9 of 14 cores were above the International Concrete Repair Institute (ICRI) recommended bond strength of 100 psi.

Bridge 1-748N: The design strength of the concrete deck is 3000 psi. The tested cores resulted in an average compressive strength of 5440 psi, with a range of 4590 psi to 6180 psi.

Three (3) depth results in the base structural deck (0.5", 1", and 2") were obtained from each Water soluble chloride ion core sample. The top layer of steel is located at 1.25" – 1.5" according to the plans. The maximum chloride content is 0.14 lbs./c.y. at the 0.5" depth (Sample 748-N2-2C), 0.06 lbs./c.y. at the 1" depth (Sample 748-N2-2C), and 0.02 lbs./c.y. at the 2" depth (Sample 748-N2-2C). In accordance with DelDOT's Bridge Design Manual May 2005 Figure 9-1, a level of chloride contamination from 0 to 1.3 is considered low, 1.3 to 2.0 is considered moderate, and greater than 2.0 is considered advanced. Therefore chloride contamination in the upper and lower layers is considered low.

Failure of the pull test had a large variability, ranging between 106 psi to 212 psi, with the failure plane noted between the overlay wearing surface and the structural slab bond line. 6 of 6 cores were above the ICRI recommended bond strength of 100 psi.

Bridge 1-748S: The design strength of the concrete deck is 3000 psi. The tested cores resulted in an average compressive strength of 5520 psi, with a range of 4770 psi to 6280 psi.

Three (3) depth results in the base structural deck (0.5", 1", and 2") were obtained from each Water soluble chloride ion core sample. The top layer of steel is located at 1.25" – 1.5" according to the plans. The maximum chloride content is 0.05 lbs./c.y. at the 0.5" depth (Sample 748S-1C), 0.04 lbs./c.y. at the 1" depth (Sample 748S-1C), and 0.02 lbs./c.y. at the 2" depth (Sample 748S-1C). In accordance with DelDOT's Bridge Design Manual May 2005 Figure 9-1, a level of chloride contamination from 0 to 1.3 is considered low, 1.3 to 2.0 is considered moderate, and greater than 2.0 is considered advanced. Therefore chloride contamination in the upper and lower layers is considered low.

Failure of the pull test had a large variability, ranging between 71 psi to 170 psi, with the failure plane noted between the overlay wearing surface and the structural slab bond line. 5 of 6 cores were above the ICRI recommended bond strength of 100 psi.

4.1.4.2 Petrographic Analysis Results

Bridge 1-748: Cores 748NB-1P – 748NB-4P and 748SB-1P – 748SB-4P were sent to Highbridge Materials Consulting, Inc. for petrographic and air voids analysis. The following is a summary of the test results. For

further information please reference the “*Petrographic Examination Report*” prepared by Highbridge Materials Consulting, Inc. dated March 22, 2015, in Appendix E.

The petrographic analysis of the cores indicated that the concrete materials were well mixed, cast and consolidated. There were no obvious signs of workmanship deficiencies. The water to cement ratio for the cores is estimated to be in the mid to high 0.40's. All eight (8) cores had trace to early stages of alkali silica reactivity (ASR) present – primarily in the chert fine particles. Cores 748NB-1P, 748NB-4P and 748SB-3P had evidence of mild dedolomitization (corrosion) in the dolostone grains. All of the cores had very minor and early stage micro cracking extending from the effected grains. Trace evidence of ASR gel was found in a few of these micro cracks.

The total air voids observed in cores 748NB-1P, 748NB-2P, 748NB-3P and 748NB-4P was 5.2%, 5.1%, 5.1% and 6.8% respectively. The total air voids observed in cores 748SB-1P, 748SB-2P, 748SB-3P and 748SB-4P were 8.7%, 5.6%, 5.6% and 9.1% respectively. The air contents for cores 748SS-1P and 748SB-4P exceed modern specifications for concrete that is exposed to freezing and thawing. The air contents for the remaining cores are within modern specifications. Current specifications for concrete exposed to freezing and thawing cycles is 3.5% to 6.5% per ACI 318 Chapter 4 Section 4. Concrete with high air content may have lower compressive strengths. There were two (2) instances where the compressive strengths of the cores were significantly lower than the other tested cores; these lower compressive strengths could be the result of higher air void contents.

It was also noted that the air void structures in cores 748NB-2P, 748NB-3P and 748SB-3P had high spacing factors. Concrete with poorly developed air structures tend to have durability issues due to the imbalance of correctly sized voids to accommodate water infiltration and expansion during freezing events.

Bridge 1-748N: Cores 748-N2-1P, 748-N2-2P and 748-N3-1P were sent to Highbridge Materials Consulting, Inc. for petrographic and air voids analysis. The following is a summary of the test results. For further information please reference the “*Petrographic Examination Report*” prepared by Highbridge Materials Consulting, Inc. dated March 22, 2015, in Appendix E.

The petrographic analysis of the cores indicated that the concrete materials were well mixed, cast and consolidated. There were no obvious signs of workmanship deficiencies. The water to cement ratio for the core is estimated to be in the mid to high 0.40's. Cores 748-N2-1P and 748-N3-1P had trace amounts of ASR present in the chert fine aggregate with no evidence of ASR in the cut thin sections. Core 748-N2-2P had no evidence of ASR reactions.

The total air voids observed in cores 748-N2-1P, 748-N2-2P and 748-N3-1P was 8.1%, 7.5% and 5.2% respectively. The air contents for cores 748-N2-1P and 748-N2-2P exceed modern specifications for concrete that is exposed to freezing and thawing. The air content for core 748-N3-1P was within modern specifications. Current specifications for concrete exposed to freezing and thawing cycles is 3.5% to 6.5% per ACI 318 Chapter 4 Section 4. Concrete with high air content may have lower compressive strengths. The compressive strength data for the cores extracted from this structure did not indicate a reduction in strength due to this higher air content.

Bridge 1-748S: Cores 748S-1P, 748S-2P and 748S-3P were sent to Highbridge Materials Consulting, Inc. for petrographic and air voids analysis. The following is a summary of the test results. For further information please reference the “*Petrographic Examination Report*” prepared by Highbridge Materials Consulting, Inc. dated March 22, 2015, in Appendix E.

The petrographic analysis of the cores indicated that the concrete materials were well mixed, cast and consolidated. There were no obvious signs of workmanship deficiencies. The water to cement ratio for the core is estimated to be in the mid to high 0.40's. All three (3) of the cores had trace amounts of ASR present in the chert fine aggregate with no evidence of ASR in the cut thin sections for cores 748S-1P and 748S-3P. Core 748S-2P had one local indication of micro-cracking with gel pockets identified in the cut thin section.

The total air voids observed in cores 748S-1P, 748S-2P and 748S-3P was 5.0%, 7.8% and 9.6% respectively. The air contents for cores 748S-2P and 748S-3P exceed modern specifications for concrete that is exposed to freezing and thawing. The air content for core 748S-1P was within modern specifications. Current specifications for concrete exposed to freezing and thawing cycles is 3.5% to 6.5% per ACI 318 Chapter 4 Section 4. Concrete with high air content may have lower compressive strengths. The compressive strength data for the cores extracted from this structure did not indicate a reduction in strength due to this higher air content. It was also noted that the air void structures in cores 748S-1P and 748S-3P had low specific surface characteristics and 748S-1P had a high spacing factor. Concrete with poorly developed air structures tend to have durability issues due to the imbalance of correctly sized voids to accommodate water infiltration and expansion during freezing events.

4.1.5 Paint Adhesion Testing

Paint adhesion testing was performed on pre-selected locations throughout the viaduct on representative areas of distressed or peeling paint, in addition to areas where the coating system was intact. A NACE Level 1 certified inspector performed the test utilizing a portable adhesion tester in accordance with ASTM D4541. At each test location, the inspector documented a description of the failure (paint vs. adhesive), and the tensile strength (psi). Additionally, the inspector determined and recorded the coating thickness, utilizing an electronic dry film thickness gauge per the procedures outlined in SSPC-PA2. The variability of the testing results summarized in Appendix F suggests further testing locations are required. After consultation with the Department, it was agreed the entire superstructure will be repainted.

4.1.6 Summary of Findings

The following is a summary of the visual inspection findings; for further information, please reference the inspection field observation notes in Appendix H.

The concrete deck exhibits minor delaminations and spalls to the soffit, and areas of corrosion to the stay-in-place forms of BR 1-748, typically adjacent to abandoned weep drains. The deck joints typically exhibit debonded, depressed or torn joint material with some joint material completely missing (see Photo 1). The steel armoring typically exhibits surface corrosion (see Photo 1). The LMC overlay exhibits delaminations, spalls, and bituminous patches throughout (see Photos 2). 31 of 106 scuppers are 100% clogged with debris and are not functional.

The beams and girders exhibit random areas of freckled corrosion throughout, random locations of peeling and flaking paint (see Photo 4), and the ends of the beams and girders exhibit minor to severe corrosion. The webs and bearing stiffeners typically exhibit up to 1/4" painted over pitting (see Photo 5). Span 25, Girder 17 at Pier 24 exhibits severe section loss to the web and up to 100% section loss of the bearing stiffeners (see Photo 6). Steel diaphragms exhibit minor to severe corrosion at the piers, and random areas of peeling paint with exposed primer on the bottom flanges throughout. The bearings that are not greased typically exhibit minor corrosion to the plate edges, 1/2" rust laminations, 1/4" pack rust between plates, and up to 1/4" pack rust between masonry plates and pedestals (see Photos 9-13). The expansion bearings for BR 1-748N and 1-748S from Spans 47 through 60 exhibit abnormal movement with locations of over contraction/expansion (see Photo 14). Anchor bolts typically exhibit up to 20% section loss. Previous seismic retrofits have put anchor bolt nuts in contact with keeper plates which has the potential to restrict proper movement.

Steel pier cap exteriors (see field notes sketch in Appendix H for numbering) exhibit peeling paint with minor to moderate surface corrosion, up to 1/8" rust delaminations and painted over 1/8" deep pitting to the webs. There is pack rust up to 1/4" thick between built up members (see Photo 15), the bottom flange rivets exhibit up to 10% painted over section loss (see Photo 19), and the web bolt nuts exhibit up to 20% painted over section loss. Pier Caps 24 through 26 exhibit up to 3/8" section loss to the top flange edges due to joint leakage. Pier Cap interiors exhibit minor freckled corrosion to the top flanges (see Photo 17), and moderate to severe corrosion with 10% section loss to rivets to the interior web bases and bottom flanges (see Photo 16). The drilled holes in the webs for the tie rod retrofits results in water leakage to the interior and causes 1/16" rust delaminations around the holes and ponding water on the bottom flange causing severe

corrosion. Random bays exhibit exposed steel, 1/16" rust delaminations, and up to 1/16" section loss to the bottom flanges (see Photo 18). Steel pier cap bearings exhibit flaking paint, minor to moderate corrosion to plates and bolts, minor rust laminations up to 1/16", up to 1/4" pack rust between plates (see Photo 21), painted over less than 1/16" section loss to the plates, and up to 20% section loss to the sole plate and keeper plate bolt nuts.

The concrete abutment and piers exhibit cracks with corrosion stains, delaminations, and spalls with exposed corroded steel reinforcement (see Photos 23 – 25).

4.1.6.1 Defect Photographs

The defect photos are representative of the as-inspected condition; additional photos are available upon request.



Photo 1: Torn joint seal and corroded armoring (Span 7 Northbound, Pier 6)



Photo 2: Deck spall at joint (Span 26 Northbound, Pier 26)



Photo 3: Fire damage to overlay (Span 35S)



Photo 4: Typical peeling paint with exposed primer (Span 23, Beam 9)



Photo 5: Typical beam end corrosion and pitting (Span 60N, Beam 10 at Pier 59N)



Photo 6: Corrosion and section loss at end of girder (Span 25, Girder 17 at Pier 24)



Photo 7: Previous sign structure support to be removed (Span 35N, Beam 6)



Photo 8: Missing weld to bearing stiffener (Span 48N, Bay 2 End Diaphragm at Pier 47N)



Photo 9: Typical bearing corrosion (Span 9, Pier 8, Bearing 15)



Photo 10: Concrete debris preventing movement (Span 34S, Bearing 1)



Photo 11: Painted over section loss to anchor bolt nut (Span 52N, Bearing 6)



Photo 12: Pack rust between masonry and sole plates causing uplift (Span 53N, Bearing 6 at Pier 52N)



Photo 13: Pack rust between masonry plate and shim plate preventing contraction (Span 54N, Bearing 9 at Pier 53N)



Photo 14: Over expansion (appears to be as-built condition) (Span 54N, Bearing 6)



Photo 15: Typical pack rust on bottom flange of built-up pier caps (Pier Cap 11)



Photo 16: Bottom flange rivet with section loss (Pier Cap 12 interior, east end)



Photo 17: Top flange corrosion (Pier Cap 21 interior, Bay 22)



Photo 18: Bottom flange corrosion and rust delaminations from ponding water (Pier Cap 22 interior, Bay 7)



Photo 19: Bottom flange connection rivets with section loss (Pier Cap 24, below Beam 11)



Photo 20: Steel debris (Span 11, Pier Cap 11, Bearing 3)



Photo 21: Pack Rust at bearing pin (Span 16, Pier Cap 16, Bearing 2)



Photo 22: Disconnected downspout (Pier 23, Column 1, North Face)



Photo 23: Spall with exposed corroded steel reinforcement (Pier 4 cap, East Face)



Photo 24: Delaminations and spalls with exposed corroded steel reinforcement (Pier 49S, Column 1, South Face)



Photo 25: Pedestal spall with exposed corroded steel reinforcement (Pier 55N, Pedestal 5)

4.1.7 Defect Tables

Bridge 1-748: Deck Defects - Spalls at deck ends will be replaced during the joint replacement work. The stay-in-place forms corrosion will not be repaired.

Bridge 1-748N: Deck Defects - Spalls at deck ends will be replaced during the joint replacement work.

Defect Number	Location	Description
D-31N-1	Span 31N, Bay 4, Dia 1-2	9" wide x 1'-6" long x 1" deep soffit spall with exposed and corroded steel reinforcement.
D-60N-1	Span 60N, Bay 8, Dia 1	4" wide x 1'-0" long x 1" deep soffit spall with adjacent 2'-0" wide x 2'-0" long area of delaminated concrete at the conduit support.

Bridge 1-748S: Deck Defects - Spalls at deck ends will be replaced during joint replacement work.

Defect Number	Location	Description
D-36S-2	Span 36S, Bay 3, Dia 2	6" diameter x 1/2" deep soffit spall.
D-36S-3	Span 36S, Bay 3, Dia 2	3" diameter x 1/2" deep soffit spall.
D-39S-1	Span 39S, Bay 2, Dia 1-2	1'-0" diameter x 1/2" deep area of honeycombing in soffit with exposed and corroded steel reinforcement.
D-40S-1	Span 40S, Bay 2, Dia 1	8" wide x 1'-0" long area of delaminated concrete in the soffit.

Bridge 1-748: Superstructure Defects

Defect Number	Location	Description
S-1-1	Span 1, Bay 9, Diaphragm 3	East side lower diaphragm connection has a loose bolt.
S-11-1	Span 11, Bay 7, Diaphragm 1	Unpainted high strength bolt is hand tightened (no welds at location) at east side lower diaphragm connection.
S-11-2	Span 11, Pier 11, Pier Cap Bearing 3	West face of bearing has 6" long x 6" wide x 1 1/2" thick portion of steel plate protruding from beneath masonry plate.
S-12-1	Span 12, Pier Cap 12 interior, east end	5" long x 4 1/2" wide x 1/4" deep S.L. to southeast corner of bottom flange; 1/4" deep S.L. on two connection angles; one bottom flange rivet with up to 75% S.L.
S-13-1	Span 13, Pier 12 Bearings	Bronze plate shifted to the west with 1/16" gaps at the east side and 1/4" gaps at the west side.
S-13-2	Span 13, Pier 12, Bearing 16	East anchor bolt nut backed off 1/2".
S-15-1	Span 15, Pier 15, Pier Cap Bearing 2	Up to 1/4" pack rust between the pin and sole plate at the north end.
S-15-2	Span 15, Pier 15, Pier Cap Bearing 2	Southwest anchor bolt nut is out of plumb from construction and A.B. nut with painted over section loss up to 40%
S-16-1	Span 16, Pier 16, Pier Cap Bearing 2	3/8" pack rust between the top and bottom castings and pin at the north end and 1/4" rust lamination to north washer pin.
S-17-1	Span 17, Pier 17, Pier Cap Bearing 2	8" long x 4" wide x 1/2" deep spall in column at the north end is undermining east keeper plate 1/2".
S-18-1	Span 18, Beam 1, Pier 17 to Diaphragm 1	3/4" diameter hole in top flange east of web is filled with composite material with evidence of leakage through hole.
S-20-1	Span 20, Pier Cap 20 interior, Bays 10 & 11, bottom flange and conn. angles	Evidence of ponding water with up to 1/4" thick rust delaminations; 20% section loss to approximately 80% of bottom flange bolt nuts.
S-21-1	Span 21, Pier Cap 21 interior, Bays 21,22, & east end	Top flange and top 3-feet of both webs exhibit failing paint with moderate corrosion.
S-22-1	Span 22, Pier Cap 22 interior, Bay 7	Bottom flange exhibits a 4' long x 3' wide x 1/16" deep area of section loss; rivets exhibit 75% S.L.
S-24-1	Span 24, Pier Cap 24 exterior, below Beam 11	Bottom flange angle connection, south side exhibits eight (8) rivets with up to 75% S.L.; North side exhibits three (3) rivets with 50% S.L.

Bridge 1-748: Superstructure Defects (Continued)

Defect Number	Location	Description
S-24-2	Span 24, Pier Cap 24 exterior, below Beam 17	Bottom flange angle connection, north side exhibits 15 rivets with up to 80% section loss.
S-25-1	Span 25, Girder 17, Pier 24 to Diaphragm 1	East face of web, bolster, and bearing stiffeners. This location has three (3) bearing stiffeners to the east web. The web and east stiffeners exhibit areas of pitting that were previously painted over, and are now reactivating with corrosion. The web exhibits two (2) areas of pitting (32" long x 5" high x 5/16" deep at bottom and 20" long x 8" high x 5/16" deep above the bolster) extending from the centerline of bearing past the stiffeners. The northern stiffener exhibits three (3) areas of painted over pitting up to 8" high x 8" wide x 1/8" remaining. with additional 4" high x 3" wide and 1-inch diameter areas of 100% section loss. The middle stiffener exhibits full-height x full-width x 1/8" deep pitting and an 8" height x full-width x 5/8" deep pitting at the base. The southern stiffener exhibits an 8" high x full-width x 1/4" deep area of pitting at the base. See field notes sketch in the Appendix H.

Bridge 1-748N: Superstructure Defects

Defect Number	Location	Description
S-35N-1	Span 35N, Pier 35N Bearings	Bearings appear to be frozen.
S-36N-1	Span 36N, Pier 36N, Bearing 6	1/4" of pack rust between sole plate and masonry plate preventing rotation.
S-38N-1	Span 38N, Pier 37N Bearings	Over contracted up to 1" at Bearing 5 (see bearing measurement table in Appendix H; appears to be as-built condition) at 40 degrees F.
S-39N-1	Span 39N, Pier 38N, Bearing 3	Missing west anchor bolt nut.
S-40N-1	Span 40N, Pier 40N, Bearing 1	West anchor bolt nut is not snug and is cross threaded on the bolt.
S-42N-1	Span 42N, Pier 41N, Bearing 5	1/4" of pack rust between sole plate and sliding plate with gap.
S-43N-1	Span 43N, Pier 43N, Pier Cap Bearing 2	3 of 4 anchor bolt nuts are backed off.
S-44N-1	Span 44N, Pier 44N, Bearing 6	1/8" of pack rust between sole and masonry plates. East anchor bolt nut with painted over 90% section loss.
S-47N-1	Span 47N, Pier 46N, Bearings 1, 3, and 4	1/4" of pack rust between sole plate and masonry plate preventing rotation.
S-48N-1	Span 48N, Bay 2, End Diaphragm at Pier 47N	Missing weld to Beam 2 bearing stiffener along north web and bottom flange connection (see Photo 8).
S-50N-1	Span 50N, Pier 50N Bearings	1/4" of pack rust between sold plate and masonry plate preventing rotation.

Bridge 1-748N: Superstructure Defects (Continued)

Defect Number	Location	Description
S-51N-1	Span 51N, Pier 50N, Bearings 1 and 6	1/4" pack rust between sole plate and masonry plate preventing rotation.
S-51N-2	Span 51N, Pier 51N, Bearing 6	East anchor bolt nut with painted over 90% section loss. Sole plate is 3/8" above the sliding plate due to 3/8" of pack rust.
S-52N-1	Span 52N, Pier 51N Bearings	Expanded at 40 degrees F.
S-52N-2	Span 52N, Pier 51N, Bearing 6	East anchor bolt nut with 75% section loss.
S-52N-3	Span 52N, Pier 52N, Bearing 6	1/4" pack rust between sole plate and masonry plate preventing rotation.
S-53N-1	Span 53N, Pier 52N, Bearing 5	1/4" of pack rust between sole plate and masonry plate preventing rotation.
S-53N-2	Span 53N, Pier 52N, Bearing 6	Uplifted 3/8" due to pack rust between sliding plate and masonry plate preventing rotation.
S-53N-3	Span 53N, Pier 53N, Bearings 1 to 6	Bearings are over contracted up to 1 1/8" at Bearing 6 (see bearing measurement table in Appendix H; appears to be as-built condition).
S-53N-4	Span 53N, Pier 53N, Bearing 9	Bearings appear to be frozen.
S-54N-1	Span 54N, Pier 53N Bearings	1/2" of pack rust between masonry plate and shim plate on front face. Could prevent contraction.
S-54N-2	Span 54N, Pier 53N, Bearings 1,2,5,6, and 7	Bearings are over expanded (at 37 degrees F) up to 1/2" at Bearings 5 and 6 (see bearing measurement table in Appendix H).
S-54N-3	Span 54N, Pier 53N, Bearings 8 to 9	Bearings appear to be frozen.
S-55N-1	Span 55N, Pier 55N Bearings	Expanded at 32 degrees F; appears to be as-built condition.
S-55N-2	Span 55N, Pier 55N, Bearings 3 and 8	Missing west anchor bolt nuts due to seismic retrofit.
S-55N-3	Span 55N, Pier 55N, Bearing 6	Missing east anchor bolt nut due to short anchor bolt.
S-60N-1	Span 60N, Pier 59N, Bearing 10	Uplifted 3/8" due to pack rust between sliding plate and sole plate preventing rotation.

Bridge 1-748S: Superstructure Defects

Defect Number	Location	Description
S-29S-1	Span 29S, Pier 28S, Bearings 1 and 2	Fully contracted at 38 degrees F.
S-31S-1	Span 31S, Girders 1 and 2, Diaphragm 1	Stiffeners are tack welded to bottom flanges causing a fatigue prone detail.

Bridge 1-748S: Superstructure Defects (Continued)

Defect Number	Location	Description
S-34S-1	Span 34S, Pier 34S, Bearing 1	Concrete debris left at the back of the bearing prevents proper expansion.
S-34S-2	Span 34S, Pier 34S, Bearing 5	East anchor bolt exhibits 30% painted over section loss.
S-34S-3	Span 34S, Pier 34S, Bearing 6	1/4" of pack rust between sliding plate and bronze plate that could prevent proper movement.
S-35S-1	Span 35S, Pier 35S, Bearing 1	Over contracted up to 3/4-inch (see bearing measurement table in Appendix H)
S-35S-2	Span 35S, Pier 35S Bearings	Bearings appear to be frozen.
S-36S-1	Span 36S, Pier 35S, Bearing 6	3/8" pack rust between masonry plate and shim plate on front face. Could prevent contraction.
S-36S-2	Span 36S, Pier 35S Bearings	Bearings appear to be frozen.
S-38S-1	Span 38S, Pier 37S, Bearings 1,2,4, and 6	Contracted flush with masonry plate at 30 degrees F.
S-41S-1	Span 41S, Pier 41S, Bearings 1 and 6	Bearings appear to be frozen.
S-41S-2	Span 41S, Pier 41S Bearings	Contracted flush with masonry plate at 30 degrees F.
S-43S-1	Span 43S, Pier 43S Bearings	Bearings appear to be frozen.
S-44S-1	Span 44S, Pier 43S Bearings	Over contracted (at 32 degrees F) up to 1-inch at Bearings 3 and 6 (see bearing measurement table in Appendix H; appears to be as-built condition).
S-44S-2	Span 44S, Pier 43S Bearings	Bearings appear to be frozen.
S-49S-1	Span 49S, Pier 49S, Bearings 1,3,4, and 6	3/8" of pack rust between masonry plate and shim plate on front face. Could prevent contraction.
S-49S-2	Span 49S, Pier 49S, Bearings 1,2, and 3	Over contracted (at 40 degrees F) up to 3/8" at Bearing 2 (see bearing measurement table in Appendix H; appears to be as-built condition).
S-51S-1	Span 51S, Pier 51S, Bearing 5	Contracted flush with masonry plate at 30 degrees F.
S-52S-1	Span 52S, Pier 51S, Bearings 1 and 6	1/4" of pack rust between masonry plate and shim plate on front face. Could prevent contraction.
S-52S-2	Span 52S, Pier 51S, Bearing 3	Over expanded (at 40 degrees F) 1/4" (see bearing measurement table in Appendix H; appears to be as-built condition).

Bridge 1-748S: Superstructure Defects (Continued)

Defect Number	Location	Description
S-52S-2	Span 52S, Pier 51S, Bearing 3	Over expanded (at 40 degrees F) 1/4" (see bearing measurement table in Appendix H; appears to be as-built condition).
S-52S-3	Span 52S, Pier 51S, Bearings 1,4,5, and 6	Expanded flush with masonry plate at 40 degrees F.
S-53S-1	Span 53S, Pier 53S Bearings	Over contracted (at 36 degrees F) up to 1 1/2" at Bearing 4 (see bearing measurement table in Appendix H; appears to be as-built condition).
S-54S-1	Span 54S, Pier 53S, Bearing 2	Expanded flush with masonry plate at 36 degrees F.
S-54S-2	Span 54S, Pier 53S, Bearings 4,5 and 6	Over expanded (at 36 degrees F) up to 3/8" at Bearings 4 and 6 (see bearing measurement table in Appendix H; appears to be as-built condition).
S-60S-1	Span 60S, Pier 59S Bearings	Expanded at 31 degrees F.

Bridge 1-748: Substructure Defects

Defect Number	Location	Description
A-1-1	South Abutment, North Face	Five 2'-0" long x 1/16" wide vertical/diagonal cracks at bearing seats.
A-1-2	South Abutment, West Fascia, Drainage	Severe corrosion of drainpipe running from downspout to end of slope protection.
A-1-3	South Abutment, Bay 9, Drainage	Drainpipe on slope protection is disconnected and laying on ground in front of slope protection.
P-1-1	Pier 1, North Face, Column 3	2'-0" long x 1/16" wide vertical crack with corrosion staining.
P-1-2	Pier 1, North Face, Pier Cap 1	7" wide x 11" high area of delaminated concrete.
P-1-3	Pier 1, East Face, Column 1	5" wide x 2" high x 1/4" deep spall.
P-1-4	Pier 1, South Face, Column 2	6" wide x 10" high area of delaminated concrete.
P-1-5	Pier 1, South Face, Column 2	3" wide x 6" high x 1" deep spall.
P-1-6	Pier 1, Southwest Corner, Column 1	2'-2" wide x 2'-5" high area of delaminated concrete.

Bridge 1-748: Substructure Defects (Continued)

Defect Number	Location	Description
P-1-7	Pier 1, South Face, Pedestal 14	1'-3" long x 7" high area of delaminated concrete.
P-1-8	Pier 1, Underside, Pier Cap 3	4" wide x 8" long x 1/2" deep spall with exposed steel reinforcement.
P-1-9	Pier 1, Underside, Pier Cap 3	5" wide x 5" high x 1/2" deep spall with exposed steel reinforcement.
P-1-10	Pier 1, Column 2, Drainage	Downspout partially clogged.
P-2-1	Pier 2, North Face, Pier Cap 1	2'-0" long x 1/16" wide horizontal crack with corrosion.
P-2-2	Pier 2, North Face, Column 4	1'-11" wide x 4'-0" high area of delaminated concrete with 5'-9" long x 1/16" wide vertical crack with corrosion.
P-2-3	Pier 2, North Face, Pier Cap 2SB, East Overhang	8" wide x 5" high area of delaminated concrete with 3'-0" long x 1/16" wide vertical crack.
P-2-4	Pier 2, North Face, Pier Cap 2NB, West Overhang	3'-0" long x 1/16" wide vertical crack.
P-2-5	Pier 2, Northeast Corner, Pedestal 8	6" wide x 5" high area of delaminated concrete.
P-2-6	Pier 2, East Face, Column 3	4" wide x 1'-5" high x 2 1/2" deep spall.
P-2-7	Pier 2, East Face, Column 3	3'-6" wide x 3'-0" high area of delaminated concrete.
P-2-8	Pier 2, East Face, Column 3	8" wide x 6" high area of delaminated concrete.
P-2-9	Pier 2, East Face, Pedestal 16	1'-3" long x 8" high x 1/4" deep spall.
P-2-10	Pier 2, South Face, Pier Cap 1	2'-9" wide x 6" high area of delaminated concrete.
P-2-11	Pier 2, South Face, Column 3	3'-6" wide x 3'-6" high area of delaminated concrete.
P-2-12	Pier 2, South Face, Column 3	1'-8" wide x 1'2" high area of delaminated concrete.
P-2-13	Pier 2, South Face, Column 3	1'-2" wide x 11" high area of delaminated concrete.

Bridge 1-748: Substructure Defects (Continued)

Defect Number	Location	Description
P-2-14	Pier 2, South Face, Column 4	1'-2" wide x 17'-0" high area of delaminated concrete with 1/8" wide cracking and corrosion staining.
P-2-15	Pier 2, South Face, Column 5	10" wide x 10" high area of delaminated concrete.
P-2-16	Pier 2, South Face, Pier Cap 3	1'-7" wide x 3" high area of delaminated concrete.
P-2-17	Pier 2, South Face, Pier Cap 3	2'-4" wide x 6" high area of delaminated concrete with 2'-4" long x 1/16" wide horizontal crack.
P-2-18	Pier 2, South Face, Pier Cap 3	1'-3" wide x 6" high area of delaminated concrete.
P-2-19	Pier 2, South Face, Pier Cap 3	1'-0" wide x 6" high area of delaminated concrete.
P-2-20	Pier 2, West Face, Column 4	6" wide x 17'-0" high area of delaminated concrete with 1/2" wide cracking and corrosion staining.
P-2-21	Pier 2, West Face, Pedestal 15	1'-2" long x 1/16" wide vertical crack.
P-2-22	Pier 2, Underside, Pier Cap 1, East Overhang	7" wide x 7" long area of delaminated concrete.
P-2-23	Pier 2, Underside, Pier Cap 3, East Overhang	11" wide x 11" long area of delaminated concrete.
P-3-1	Pier 3, North Face, Column 4	8" wide x 2'-3" high area of delaminated concrete.
P-3-2	Pier 3, North Face, Column 4	5" wide x 7" high area of delaminated concrete.
P-3-3	Pier 3, North Face, Column 4	2'-8" long x 1/16" wide horizontal crack with corrosion.
P-3-4	Pier 3, South Face, Column 4	11" wide x 2'-0" high area of delaminated concrete.
P-3-5	Pier 3, Underside, Pier Cap 2NB, West Overhang	1'-0" wide x 3'-0" long x 2" deep spall with exposed steel reinforcement.
P-3-6	Pier 3, Underside, Pier Cap 3, West Overhang	1'-8" wide x 1'-6" long area of delaminated concrete.
P-4-1	Pier 4, North Face, Pier Cap 2NB	10" wide x 10" high x 1 1/2" deep spall.

Bridge 1-748: Substructure Defects (Continued)

Defect Number	Location	Description
P-4-2	Pier 4, North Face, Pier Cap 2SB, East Overhang	2'-0" wide x 9" high x 1 1/2" deep spall with corrosion staining.
P-4-3	Pier 4, North Face, Pier Cap 3	1'-6" wide x 1'-9" high area of delaminated concrete.
P-4-4	Pier 4, North Top Corner, Pier Cap 3	2'-10" wide x 2'-4" high area of delaminated concrete with 3'-1" long x 1/16" with crack.
P-4-5	Pier 4, North Top Corner, Pier Cap 3	2'-3" long x 1/8" wide horizontal crack.
P-4-6	Pier 4, North Top Corner, Pier Cap 3	3'-0" wide x 3'-0" high area of delaminated concrete.
P-4-7	Pier 4, North Top Corner, Pier Cap 3	4'-9" wide x 2'-9" high x 2" deep spall.
P-4-8	Pier 4, East Face, Pier Cap 3	3'-9" wide x 4'-6" high x 5" deep spall with exposed steel reinforcement with 1/16" section loss.
P-4-9	Pier 4, East Face, Column 5	4" wide x 3" high x 1/2" deep spall with exposed steel reinforcement.
P-4-10	Pier 4, East Face, Column 6	8" wide x 1'-2" high area of delaminated concrete.
P-4-11	Pier 4, East Face, Column 6	8" wide x 5" high x 1/2" deep spall with exposed steel reinforcement.
P-4-12	Pier 4, East Face, Column 6	2" wide x 5" high x 1/2" deep spall.
P-4-13	Pier 4, East Face, Column 6	1'-7" wide x 10" high x 1" deep spall with exposed steel reinforcement.
P-4-14	Pier 4, East Face, Pedestal 1	2" wide x 4" high x 1/2" deep spall.
P-4-15	Pier 4, Southeast Corner, Pier Cap 2NB, East Overhang	1'-9" long x 1/16" wide vertical crack.
P-4-16	Pier 4, South Face, Pier Cap 1	6'-6" wide x 2'-2" high x 1 1/2" deep spall with exposed steel reinforcement.
P-4-17	Pier 4, South Face, Pier Cap 1	2'-6" wide x 2'-0" high area of delaminated concrete.
P-4-18	Pier 4, South Face, Pier Cap 1	4'-1" wide x 1'-1" high area of delaminated concrete.

Bridge 1-748: Substructure Defects (Continued)

Defect Number	Location	Description
P-4-19	Pier 4, South Face, Column 1	1'-8" wide x 8" high area of delaminated concrete.
P-4-20	Pier 4, South Face, Pier Cap 3	1'-11" wide x 2'-2" high area of delaminated concrete.
P-4-21	Pier 4, South Face, Pier Cap 3	12" wide x 1'-2" high area of delaminated concrete.
P-4-22	Pier 4, West Face, Column 1	1'-2" wide x 7" high area of delaminated concrete.
P-4-23	Pier 4, Underside, Pier Cap 1, West Overhang	3" wide x 3" long x 1/4" deep spall with exposed steel reinforcement.
P-4-24	Pier 4, Top, Pier Cap 1, East Overhang	2'-3" long x 1/16" wide crack.
P-5-1	Pier 5, North Face, Pier Cap 3	2" wide x 1'-0" high x 3" deep spall.
P-5-2	Pier 5, North Face, Pier Cap 3	1'-10" wide x 1'-10" high x 3" deep spall.
P-5-3	Pier 5, North Face, Pier Cap 3	4'-2" wide x 3'-3" high area of delaminated concrete.
P-5-4	Pier 5, East Face, Column 2	2" wide x 1" high x 1/4" deep spall with exposed steel reinforcement.
P-5-5	Pier 5, East Face, Column 2	6" wide x 2" high x 1/4" deep spall with exposed steel reinforcement.
P-5-6	Pier 5, East Face, Pier Cap 3	1'-8" wide x 2'-4" high area of delaminated concrete.
P-5-7	Pier 5, Underside, Pier Cap 1, East Overhang	10" wide x 8" long area of delaminated concrete.
P-5-8	Pier 5, Column 1, Drainage	Downspout clogged at the base of the column.
P-5-9	Pier 5, Column 6	Moderate vine growth throughout column.
P-6-1	Pier 6, North Face, Pier Cap 2NB, West Overhang	8" long x 1/16" wide horizontal crack.
P-6-2	Pier 6, North Face, Pier Cap 3	4'-0" long x 1/16" wide horizontal crack.

Bridge 1-748: Substructure Defects (Continued)

Defect Number	Location	Description
P-6-3	Pier 6, North Face, Pier Cap 3	1'-9" long x 1/16" wide horizontal crack.
P-6-4	Pier 6, East Face, Column 5	4" wide x 2'-0" high area of delaminated concrete.
P-6-5	Pier 6, South Face, Column 5	5" wide x 2'-0" high area of delaminated concrete.
P-6-6	Pier 6, South Face, Pier Cap 1	1'-10" wide x 9" high x 1" deep spall.
P-6-7	Pier 6, South Face, Column 3	10'-0" long x 1/16" wide vertical crack with corrosion.
P-6-8	Pier 6, South Face, Column 3	3'-0" long x 1/16" wide vertical crack with corrosion.
P-6-9	Pier 6, South Face, Column 4	12'-0" long x 1/8" wide vertical crack with corrosion.
P-6-10	Pier 6, South Face, Pier Cap 2SB, East Overhang	1'-6" long x 1/16" wide vertical crack.
P-6-11	Pier 6, South Face, Pier Cap 2NB, West Overhang	7" long x 1/16" wide vertical crack.
P-6-12	Pier 6, South Face, Pier Cap 2NB, West Overhang	9" long x 1/16" wide horizontal crack.
P-6-13	Pier 6, South Face, Column 4	11" wide x 1'-1" high area of delaminated concrete.
P-6-14	Pier 6, South Face, Column 4	1'-6" wide x 1'-6" high area of delaminated concrete.
P-6-15	Pier 6, South Face, Pier Cap 2NB, East Overhang	8" wide x 4" high area of delaminated concrete.
P-6-16	Pier 6, South Face, Pier Cap 3	2'-8" long x 1/16" wide horizontal crack.
P-6-17	Pier 6, South Face, Pier Cap 3	2'-6" long x 1/16" wide horizontal crack with corrosion staining.
P-6-18	Pier 6, South Face, Pedestal 1	1'-2" long x 1/32" wide vertical crack.
P-6-19	Pier 6, Southeast Corner, Pier Cap 3	1'-2" wide x 1'-2" long area of delaminated concrete.

Bridge 1-748: Substructure Defects (Continued)

Defect Number	Location	Description
P-6-20	Pier 6, West Face, Column 4	2'-3" long x 1/16" wide crack with corrosion staining.
P-6-21	Pier 6, Underside, Pier Cap 1, West Overhang	2'-0" wide x 2'-0" long area of delaminated concrete.
P-6-22	Pier 6, Underside, Pier Cap 2NB, East Overhang	2'-4" long x 1/16" wide crack.
P-6-23	Pier 6, Underside, Pier Cap 3, West Overhang	8" wide x 8" long x 1" deep spall with exposed steel reinforcement.
P-6-24	Pier 6, Underside, Pier Cap 3, West Overhang	2'-2" wide x 3'-6" long area of delaminated concrete.
P-6-25	Pier 6, Underside, Pier Cap 3	1'-6" wide x 2'-9" long x 2 1/2" deep spall with exposed steel reinforcement.
P-6-26	Pier 6, Underside, Pier Cap 3	2'-9" wide x 2'-4" long area of delaminated concrete.
P-6-27	Pier 6, Underside, Pier Cap 3	1'-4" wide x 1'-0" long area of delaminated concrete.
P-6-28	Pier 6, Underside, Pier Cap 3	3'-9" wide x 4'-6" long area of delaminated concrete.
P-6-29	Pier 6, Underside, Pier Cap 3, East Overhang	3'-0" wide x 3'-0" long x 2 1/2" deep spall with exposed steel reinforcement.
P-6-30	Pier 6, Underside, Pier Cap 3	2'-7" long x 1/16" wide crack.
P-6-31	Pier 6, Column 6	Moderate vine growth throughout column and on bearing at east end.
P-7-1	Pier 7, North Face, Column 3	3'-0" long x 1/16" wide vertical crack with corrosion staining.
P-7-2	Pier 7, South Face, Pier Cap 2SB, West Overhang	7" long x 1/16" wide horizontal crack.
P-7-3	Pier 7, South Face, Pier Cap 2SB	2'-6" long x 1/16" wide horizontal crack with corrosion staining.
P-7-4	Pier 7, South Face, Pier Cap 2SB, East Overhang	1'-4" long x 1/16" wide horizontal crack.

Bridge 1-748: Substructure Defects (Continued)

Defect Number	Location	Description
P-7-5	Pier 7, South Face, Pier Cap 2NB, West Overhang	7" long x 1/16" wide horizontal crack.
P-7-6	Pier 7, Southwest Corner, Column 3	8" wide x 1'-10" high area of delaminated concrete.
P-7-7	Pier 7, Southwest Corner, Column 3	8" wide x 2'-7" high area of delaminated concrete.
P-7-8	Pier 7, South Face, Column 3	7" wide x 3'-9" high area of delaminated concrete with up to 1/8" wide cracking and corrosion staining.
P-7-9	Pier 7, South Face, Column 3	1'-0" wide x 4" high area of delaminated concrete.
P-7-10	Pier 7, South Face, Pier Cap 3	1'-10" wide x 6" high x 4 1/2" deep spall with exposed steel reinforcement.
P-7-11	Pier 7, Underside, Pier Cap 3, East Overhang	1'-6" wide x 1'-6" long x 1 1/2" deep spall with exposed steel reinforcement.
P-7-12	Pier 7, Underside, Pier Cap 3	8" wide x 8" long x 2 1/2" deep spall.
P-8-1	Pier 8, North Face, Pier Cap 1	8" wide x 2" high x 1 1/2" deep spall.
P-8-2	Pier 8, North Face, Pier Cap 2NB, West Overhang	2'-6" long x 1/16" wide vertical crack with corrosion staining.
P-8-3	Pier 8, North Face, Column 3	1'-9" wide x 1'-9" high x 1/2" deep spall.
P-8-4	Pier 8, North Face, Column 3	1'-2" wide x 2'-10" high area of delaminated concrete.
P-8-5	Pier 8, North Face, Column 3	9" wide x 4" high x 1/2" deep spall.
P-8-6	Pier 8, North Face, Column 3	4'-6" long x 1/16" wide vertical crack with corrosion staining.
P-8-7	Pier 8, North Face, Column 3	1'-6" wide x 2'-4" high area of delaminated concrete.
P-8-8	Pier 8, North Face, Pier Cap 3	4'-0" long x 1/16" wide horizontal crack with corrosion staining.

Bridge 1-748: Substructure Defects (Continued)

Defect Number	Location	Description
P-8-9	Pier 8, North Face, Pier Cap 3	5'-6" long x 1/16" wide horizontal crack with corrosion staining.
P-8-10	Pier 8, North Face, Pier Cap 3	10" wide x 3" high x 2" deep spall.
P-8-11	Pier 8, East Face, Column 6	2'-0" long x 1/16" wide vertical crack with corrosion staining.
P-8-12	Pier 8, East Face, Column 6	8" wide x 1'-3" high area of delaminated concrete.
P-8-13	Pier 8, East Face, Column 6	5" wide x 5" high x 1/2" deep spall with exposed steel reinforcement.
P-8-14	Pier 8, East Face, Column 6	9" wide x 7" high x 1/2" deep spall with exposed steel reinforcement.
P-8-15	Pier 8, East Face, Column 6	8" wide x 8" high x 1/2" deep spall with exposed steel reinforcement.
P-8-16	Pier 8, East Face, Pedestal 3	6" wide x 6" high x 1" deep spall with exposed steel reinforcement.
P-8-17	Pier 8, South Face, Pier Cap 2NB, West Overhang	9" long x 1/16" wide horizontal crack.
P-8-18	Pier 8, South Face, Pier Cap 2NB, West Overhang	2'-0" long x 1/16" wide vertical crack with corrosion staining.
P-8-19	Pier 8, South Face, Column 3	7" wide x 7" high x 1/2" deep spall with exposed steel reinforcement.
P-8-20	Pier 8, South Face, Column 3	6" wide x 6" high area of delaminated concrete.
P-8-21	Pier 8, South Face, Column 3	4" wide x 8" high x 1/2" deep spall.
P-8-22	Pier 8, South Face, Column 3	4" wide x 6" high x 1/2" deep spall with exposed steel reinforcement.
P-8-23	Pier 8, South Face, Pier Cap 3	2'-6" long x 1/16" wide horizontal crack with corrosion.
P-8-24	Pier 8, South Face, Pier Cap 3	2'-10" long x 1/16" wide horizontal crack with corrosion.
P-8-25	Pier 8, South Face, Pier Cap 3	3'-0" long x 1/16" wide horizontal crack with corrosion.

Bridge 1-748: Substructure Defects (Continued)

Defect Number	Location	Description
P-8-26	Pier 8, South Face, Pier Cap 3	5'-0" long x 1/16" wide horizontal crack with corrosion.
P-8-27	Pier 8, South Face, Pier Cap 3	10" wide x 8" long area of delaminated concrete.
P-8-28	Pier 8, West Face, Column 3	1'-9" wide x 1'-5" high area of delaminated concrete.
P-8-29	Pier 8, West Face, Column 6	8" wide x 1'-3" high area of delaminated concrete.
P-8-30	Pier 8, West Face, Pedestal 1	1'-10" wide x 11" high x 1 1/2" deep spall.
P-8-31	Pier 8, West Face, Pedestal 1	1'-8" wide x 8" high area of delaminated concrete.
P-8-32	Pier 8, West Face, Pedestal 16	9" wide x 9" high x 1/2" deep spall.
P-8-33	Pier 8, Underside, Pier Cap 3	4'-0" long x 1/16" wide crack with corrosion staining.
P-8-34	Pier 8, Underside, Pier Cap 3	7" wide x 1'-3" long area of delaminated concrete.
P-8-35	Pier 8, Underside, Pier Cap 3	9" wide x 9" long x 1" deep spall with exposed steel reinforcement.
P-9-1	Pier 9, North Face, Pier Cap 1	2'-0" wide x 6" high area of delaminated concrete.
P-9-2	Pier 9, North Face, Pier Cap 1	3'-7" wide x 6" high area of delaminated concrete.
P-9-3	Pier 9, North Face, Pier Cap 3	4" wide x 8" high x 1/2" deep spall.
P-9-4	Pier 9, North Face, Pier Cap 3	4" wide x 6" high x 1/2" deep spall.
P-9-5	Pier 9, North Face, Pier Cap 3	9" wide x 9" high area of delaminated concrete.
P-9-6	Pier 9, North Face, Pier Cap 3	4'-11" long x 1/8" wide horizontal crack with corrosion staining.
P-9-7	Pier 9, North Face, Pedestal 16	9" wide x 1'-1" high x 1/2" deep spall.

Bridge 1-748: Substructure Defects (Continued)

Defect Number	Location	Description
P-9-8	Pier 9, North Face, Pedestal 16	10" wide x 1'-0" high x 1/2" deep spall.
P-9-9	Pier 9, East Face, Pedestal 16	4'-0" wide x 1'-4" high x 1/2" deep spall.
P-9-10	Pier 9, South Face, Column 1	1'-3" wide x 1'-0" high area of delaminated concrete.
P-9-11	Pier 9, South Face, Column 1	4" wide x 8" high area of delaminated concrete.
P-9-12	Pier 9, Southeast Corner, Column 1	7" wide x 1'-0" high area of delaminated concrete.
P-9-13	Pier 9, South Face, Column 3	7" wide x 1'-2" high area of delaminated concrete.
P-9-14	Pier 9, South Face, Pier Cap 2SB, East Overhang	8" wide x 6" high area of delaminated concrete.
P-9-15	Pier 9, South Face, Pier Cap 3	3'-2" long x 1/16" wide horizontal crack.
P-9-16	Pier 9, South Face, Pier Cap 3	6" wide x 7" high x 3/4" deep spall with exposed steel reinforcement.
P-9-17	Pier 9, South Face, Pier Cap 3	3" wide x 7" high x 1/4" deep spall.
P-9-18	Pier 9, South Face, Pier Cap 3	3" wide x 3" high spall with exposed steel reinforcement.
P-9-19	Pier 9, West Face, Column 2	5 1/2" wide x 5 1/2" high x 1/2" deep spall with exposed steel reinforcement.
P-9-20	Pier 9, West Face, Column 2	3 1/2" wide x 2" high x 1/2" deep spall with exposed steel reinforcement.
P-9-21	Pier 9, West Face, Pedestal 16	7" wide x 7" high area of delaminated concrete.
P-9-22	Pier 9, Underside, Pier Cap 1	1'-6" wide x 1'-0" long x 1" deep spall with exposed steel reinforcement.
P-9-23	Pier 9, Top Face, Pier Cap 2NB	Up to 2" deep debris between the Span 10, Beam 9 bearing and pedestal.
P-10-1	Pier 10, North Face, Column 2	4" wide x 8 1/2" high x 1/2" deep spall.

Bridge 1-748: Substructure Defects (Continued)

Defect Number	Location	Description
P-10-2	Pier 10, North Face, Column 3	3" wide x 3" high x 1/2" deep spall with exposed steel reinforcement.
P-10-3	Pier 10, North Face, Column 3	3" wide x 3" high x 1/2" deep spall with exposed steel reinforcement.
P-10-4	Pier 10, East Face, Column 1	2" wide x 6" high x 2" deep spall with exposed steel reinforcement.
P-10-5	Pier 10, East Face, Column 1	1'-0" wide x 7" high x 1" deep spall with exposed steel reinforcement.
P-10-6	Pier 10, Southeast Corner, Column 1	6" wide x 1'-7 1/2" high x 4" deep spall with exposed steel reinforcement.
P-10-7	Pier 10, South Face, Column 1	11" wide x 11" high x 3/4" deep spall with exposed steel reinforcement.
P-10-8	Pier 10, South Face, Column 1	3" wide x 7" high x 1/2" deep spall with exposed steel reinforcement.
P-10-9	Pier 10, South Face, Column 1	5" wide x 5" high x 1/2" deep spall with exposed steel reinforcement.
P-11-1	Pier 11, Top, Column 3	1'-0" wide x 4'-0" long area of deteriorated concrete.
P-11-2	Pier 11, Column 2, Drainage	Above the bend in the downspout there is a 1'-0" diameter area of corrosion with <1/16" section loss.
P-12-1	Pier 12, North Face, Column 3	1'-3" wide x 2'-0" high area of delaminated concrete.
P-12-2	Pier 12, East Face, Column 3	1'-3" wide x 1'-3" high area of delaminated concrete.
P-12-3	Pier 12, East Face, Column 3	1'-6" wide x 1'-8" high area of delaminated concrete.
P-12-4	Pier 12, South Top Corner, Column 3	6" wide x 6" high x 1" deep spall.
P-12-5	Pier 12, West Top Corner, Column 3	1'-1" wide x 1'-10" high x 1/2" deep spall.
P-12-6	Pier 12, Column 2, Drainage	Top of downspout on the north face exhibits minor corrosion.
P-13-1	Pier 13, East Face, Column 3	1'-1" wide x 6" high x 1/2" deep spall.

Bridge 1-748: Substructure Defects (Continued)

Defect Number	Location	Description
P-13-2	Pier 13, South Top Corner, Column 1	4" wide x 5" high x 2" deep spall.
P-13-3	Pier 13, Column 2, Drainage	At the base of the column the coupler is partially disconnected and debris is protruding out.
P-13-4	Pier 13, Midspan, Drainage.	Downspout hopper is clogged with debris.
P-14-1	Pier 14, West Face, Column 2	2" wide x 2" high x 1/2" deep spall with exposed steel reinforcement.
P-14-2	Pier 14, West Face, Column 2	2" wide x 2" high x 1/2" deep spall with exposed steel reinforcement.
P-16-1	Pier 16, South Top Corner, Column 1	5" wide x 8" long x 1" deep spall.
P-17-1	Pier 17, North Top Corner, Column 3	11" wide x 2 1/2" high x 1" deep spall.
P-17-2	Pier 17, South Face, Column 1	11" wide x 1'-1" high area of delaminated concrete.
P-17-3	Pier 17, Southeast Corner, Column 2	8" wide x 2'-0" high area of delaminated concrete.
P-17-4	Pier 17, Southeast Corner, Column 2	8" wide x 1'-6" high area of delaminated concrete.
P-17-5	Pier 17, Top, Column 2	6" wide x 8 1/2" long area of delaminated concrete.
P-17-6	Pier 17, Top, Column 2	2 1/2" wide x 7" long area of delaminated concrete.
P-17-7	Pier 17, Column 3, Drainage	Downspout is clogged at the base of the column with observed leakage.
P-18-1	Pier 18, East Face, Column 1	12" wide x 9" high area of delaminated concrete.
P-18-2	Pier 18, East Face, Column 1	6" wide x 1'-5" high area of delaminated concrete.
P-18-3	Pier 18, East Face, Column 2	8" wide x 5" high area of delaminated concrete.
P-18-4	Pier 18, West Face, Column 2	1'-9" long x 1/32" wide vertical crack.

Bridge 1-748: Substructure Defects (Continued)

Defect Number	Location	Description
P-18-5	Pier 18, Column 2, Drainage	Coupler for downspout at base of column is disconnected.
P-19-1	Pier 19, North Face, Column 2	2" wide x 2" high x 1/2" deep spall.
P-19-2	Pier 19, North Face, Column 2	2" wide x 2" high x 1/2" deep spall.
P-19-3	Pier 19, North Face, Column 2	2" wide x 2" high x 1/2" deep spall.
P-19-4	Pier 19, North Face, Column 2	2" wide x 2" high x 1/2" deep spall.
P-19-5	Pier 19, North Face, Column 2	2" wide x 2" high x 1/2" deep spall.
P-19-6	Pier 19, South Face, Column 2	10 1/2" wide x 1'-3" high x 1 1/2" deep spall.
P-19-7	Pier 19, West Face, Column 2	2" wide x 2" high x 1/2" deep spall.
P-19-8	Pier 19, Column 2, Drainage	At top of joint collar, the clamp has moderate to severe corrosion throughout.
P-19-9	Pier 19, Column 1, Drainage	At base of north face of column, downspout is clogged and coupler is partially disconnected.
P-20-1	Pier 20, North Face, Column 1	5 1/2" wide x 1'-10" high area of delaminated concrete.
P-20-2	Pier 20, North Face, Column 2	1'-6" long x hairline vertical crack with corrosion staining.
P-20-3	Pier 20, North Face, Column 3	1 1/2" wide x 7" long x 1" deep spall.
P-20-4	Pier 20, South Face, Column 1	8" wide x 8" high area of delaminated concrete.
P-20-5	Pier 20, Southeast Corner, Column 2	2'-7" wide x 4'-2" high x 5" deep spall with exposed steel reinforcement.
P-20-6	Pier 20, West Face, Column 1	7" wide x 8" high x 2 1/2" deep spall.
P-20-7	Pier 20, West Face, Column 2	5" wide x 1'-1" high area of delaminated concrete.

Bridge 1-748: Substructure Defects (Continued)

Defect Number	Location	Description
P-20-8	Pier 20, Top, Column 3	9" wide x 9" long area of delaminated concrete.
P-20-9	Pier 20, Top, Column 3	1'-11" wide x 9" long area of delaminated concrete.
P-20-10	Pier 20, Top, Column 3	11" wide x 3'-6" long area of delaminated concrete.
P-20-11	Pier 20, Column 1, Drainage	Downspout is clogged and exhibits corrosion staining throughout.
P-21-1	Pier 21, Northwest Corner, Column 1	1'-2" wide x 1'-1" high x 4" deep spall with exposed steel reinforcement.
P-21-2	Pier 21, East Face, Column 2	1'-6" wide x 1'-0" high x 1" deep spall with exposed steel reinforcement.
P-21-3	Pier 21, East Face, Column 2	1'-6" wide x 10" high x 1" deep spall with exposed steel reinforcement.
P-21-4	Pier 21, East Face, Column 2	1'-6" wide x 8" high area of delaminated concrete.
P-21-5	Pier 21, East Face, Column 2	1'-0" wide x 8" high x 1" deep spall with exposed steel reinforcement.
P-21-6	Pier 21, East Face, Column 2	10 1/2" wide x 8" high area of delaminated concrete.
P-21-7	Pier 21, East Face, Column 2	3" wide x 3" high x 1/2" deep spall with exposed steel reinforcement.
P-21-8	Pier 21, East Face, Column 2	4" wide x 1'-1" high x 1" deep spall with exposed steel reinforcement.
P-21-9	Pier 21, East Face, Column 2	1'-3" wide x 1'-7" high area of delaminated concrete.
P-21-10	Pier 21, East Face, Column 2	7" wide x 5" high area of delaminated concrete.
P-21-11	Pier 21, East Face, Column 2	8" wide x 7 1/2" high x 1/2" deep spall with exposed steel reinforcement.
P-21-12	Pier 21, East Face, Column 2	10" wide x 10" high x 1 1/2" deep spall.
P-21-13	Pier 21, East Face, Column 1	2" wide x 2" high area of delaminated concrete.

Bridge 1-748: Substructure Defects (Continued)

Defect Number	Location	Description
P-21-14	Pier 21, South Face, Column 1	6" wide x 3" high x 1 1/2" deep spall.
P-21-15	Pier 21, South Face, Column 1	6" wide x 2" high area of delaminated concrete.
P-21-16	Pier 21, Top, Column 3	4" wide x 4" long x 1/2" deep spall with exposed steel reinforcement.
P-21-17	Pier 21, Column 1, Drainage	Coupler for downspout at base of column is disconnected.
P-22-1	Pier 22, East Face, Column 1	5" wide x 4" high x 1/2" deep spall with exposed steel reinforcement.
P-22-2	Pier 22, East Face, Column 1	7" wide x 7" high x 1/2" deep spall with exposed steel reinforcement.
P-22-3	Pier 22, East Face, Column 1	3" wide x 3" high x 1/2" deep spall with exposed steel reinforcement.
P-22-4	Pier 22, East Face, Column 1	3" wide x 3" high x 1/2" deep spall with exposed steel reinforcement.
P-22-5	Pier 22, East Face, Column 1	6" wide x 3" high x 1/2" deep spall with exposed steel reinforcement.
P-22-6	Pier 22, East Face, Column 1	9" wide x 6" high x 1/2" deep spall with exposed steel reinforcement.
P-22-7	Pier 22, South Face, Column 1	9" wide x 6" high x 1/2" deep spall with exposed steel reinforcement.
P-22-8	Pier 22, South Face, Column 1	1'-0" wide x 10" high area of delaminated concrete.
P-22-9	Pier 22, South Face, Column 2	2" wide x 2" high x 1/2" deep spall.
P-22-10	Pier 22, South Face, Column 2	2" wide x 2" high x 1/2" deep spall.
P-22-11	Pier 22, Column 1, Drainage	Coupler for downspout at base of column is disconnected.
P-22-12	Pier 22, Column 2, Drainage	At north side of column there is an open hole that the downspout is nested inside (falling/tripping hazard).
P-23-1	Pier 23, North Face, Column 1	2'-6" long x 3/32" wide vertical crack with corrosion staining.

Bridge 1-748: Substructure Defects (Continued)

Defect Number	Location	Description
P-23-2	Pier 23, North Face, Column 1	3'-0" long x 1/16" wide vertical crack with corrosion staining.
P-23-3	Pier 23, North Face, Column 2	9" wide x 1'-2" high area of delaminated concrete.
P-23-4	Pier 23, North Face, Column 2	6" wide x 6" high x 1/2" deep spall with exposed steel reinforcement.
P-23-5	Pier 23, East Face, Column 2	5" wide x 5" high x 1/2" deep spall with exposed steel reinforcement.
P-23-6	Pier 23, South Face, Column 2	7" wide x 1'-8" high area of delaminated concrete.
P-23-7	Pier 23, Column 1, Drainage	Coupler for downspout at base of column is disconnected and downspout is filled with debris.
P-24-1	Pier 24, North Face, Column 3	5" wide x 3" high x 1/4" deep spall.
P-24-2	Pier 24, East Face, Column 2	2" wide x 3" high x 1/2" deep spall with exposed steel reinforcement.
P-24-3	Pier 24, Top, Column 3	3" wide x 3" long x 1/2" deep spall.
P-25-1	Pier 25, North Face, Column 1	4" wide x 2" high x 1/2" deep spall with exposed steel reinforcement.
P-25-2	Pier 25, West Face, Column 1	5" wide x 1'-0" high x 1" deep spall.
P-25-3	Pier 25, West Face, Column 2	6" wide x 3 1/2" high x 1/4" deep spall with exposed steel reinforcement.
P-25-4	Pier 25, West Face, Column 2	6" wide x 3 1/2" high x 1/4" deep spall with exposed steel reinforcement.
P-25-5	Pier 25, West Face, Column 2	6" wide x 3 1/2" high x 1/4" deep spall with exposed steel reinforcement.
P-26-1	Pier 26, Southeast Corner, Column 3	1'-2" wide x 1'-0" high area of delaminated concrete.
P-26-2	Pier 26, South Face, Column 1	2'-10" long x 1/16" wide vertical crack.
P-26-3	Pier 26, South Face, Column 1	1'-6" wide x 1'-2" high area of delaminated concrete.

Bridge 1-748: Substructure Defects (Continued)

Defect Number	Location	Description
P-26-4	Pier 26, South Face, Column 1	2'-0" wide x 1'-2" high area of delaminated concrete.
P-26-5	Pier 26, South Face, Column 2	11" wide x 11" high area of delaminated concrete.
P-26-6	Pier 26, West Face, Column 1	4'-6" long x 1/16" wide vertical crack.
P-26-7	Pier 26, West Face, Column 1	2'-9" long x 1/16" wide vertical crack with corrosion staining.
P-26-8	Pier 26, West Face, Column 1	2'-0" long x 1/16" wide vertical crack with corrosion staining.
P-26-9	Pier 26, West Face, Column 1	2'-9" wide x 4'-8" high area of delaminated concrete with 1/16" wide vertical crack.
P-26-10	Pier 26, West Face, Column 1	1'-0" wide x 9" high area of delaminated concrete.
P-26-11	Pier 26, West Face, Column 1	1'-9" wide x 1'-2" high area of delaminated concrete.
P-26-12	Pier 26, West Face, Column 1	1'-0" wide x 1'-0" high area of delaminated concrete.
P-26-13	Pier 26, West Face, Column 1	1'-0" wide x 6" high area of delaminated concrete.
P-26-14	Pier 26, Top, Column 1	2'-9" wide x 3" high x 1" deep spall.
P-26-15	Pier 26, Column 1, Drainage	Coupler for downspout at base of column is disconnected and downspout is filled with debris.

Bridge 1-748N: Substructure Defects

Defect Number	Location	Description
P-27N-1	Pier 27N, South Face, Column 2	1'-9" wide x 2'-0" high area of delaminated concrete.
P-27N-2	Pier 27N, Column 1, Drainage	Downspout coupler at the base of the column is disconnected and downspout is clogged.
P-28N-1	Pier 28N, South Face, Pier Cap 1	10" wide x 10" high area of delaminated concrete.
P-28N-2	Pier 28N, South Face, Pier Cap 1	2'-6" wide x 6" high area of delaminated concrete with 1/16" wide horizontal crack with corrosion staining.
P-28N-3	Pier 28N, South Face, Column 2	6" wide x 6" high x 1/2" deep spall with exposed steel reinforcement.
P-28N-4	Pier 28N, Column 1, Drainage	Downspout coupler at the base of the column is disconnected and downspout is clogged.
P-28N-5	Pier 28N, Column 1, Drainage	Downspout hopper at underside of deck is filled with debris.
P-29N-1	Pier 29N, East Face, Column 2	9" wide x 1'-0" high area of delaminated concrete.
P-29N-2	Pier 29N, Southwest Corner, Column 1	7" wide x 1'-6" high area of delaminated concrete.
P-29N-3	Pier 29N, Southeast Corner, Column 2	1'-8" wide x 1'-2" high x 3" deep spall with exposed steel reinforcement.
P-29N-4	Pier 29N, West Face, Column 2	4" wide x 4" high x 1/4" deep spall with exposed steel reinforcement.
P-29N-5	Pier 29N, West Face, Pedestal 6	3'-4" wide x 8" high x 4" deep spall with exposed and corroded steel reinforcement.
P-29N-6	Pier 29N, Underside, Pier Cap	1'-0" wide x 1'-4" long area of delaminated concrete.
P-31N-1	Pier 31N, South Face, Pedestal 3	3" wide x 3" high x 1/4" deep spall with exposed steel reinforcement.
P-31N-2	Pier 31N, West Face, Pedestal 2	9" wide x 7" high x 1/4" deep spall with exposed steel reinforcement.
P-32N-1	Pier 32N, East Face, Pier Cap	2'-6" long x 1/16" wide crack.
P-32N-2	Pier 32N, Underside, Pier Cap	1'-9" wide x 1'-6" long area of delaminated concrete.
P-32N-3	Pier 32N, Underside, Pier Cap	1'-3" wide x 1'-7" long area of delaminated concrete.
P-33N-1	Pier 33N, Underside, Pier Cap	3'-1" wide x 3'-6" long area of delaminated concrete.
P-34N-1	Pier 34N, North Face, Column 1	6" wide x 8" high area of delaminated concrete.
P-34N-2	Pier 34N, North Face, Column 1	5" wide x 2'-6" high area of delaminated concrete.
P-34N-3	Pier 34N, Northwest Corner, Column 1	1'-0" wide x 2'-0" high x 2 1/2" deep spall with exposed steel reinforcement.

Bridge 1-748N: Substructure Defects (Continued)

Defect Number	Location	Description
P-34N-4	Pier 34N, Top Face, Pier Cap	2'-10" wide x 2'-1" long area of delaminated concrete between Pedestals 1 and 2.
P-35N-1	Pier 35N, North Face, Pier Cap	1'-4" long x 1/16" wide horizontal crack with corrosion staining.
P-35N-2	Pier 35N, South Face, Column 2	2 1/2" wide x 7" high x 3/4" deep spall with exposed steel reinforcement.
P-35N-3	Pier 35N, South Face, Column 2	5" wide x 3" high x 1/2" deep spall with exposed steel reinforcement.
P-35N-4	Pier 35N, South Face, Column 2	4" wide x 1 1/2" high x 1/2" deep spall with exposed steel reinforcement.
P-35N-5	Pier 35N, South Face, Column 2	1'-1" wide x 4" high x 1/4" deep spall with exposed steel reinforcement.
P-35N-6	Pier 35N, South Face, Column 2	1'-7" wide x 4" high x 3/4" deep spall with exposed steel reinforcement.
P-36N-1	Pier 36N, North Face, Column 2	6" wide x 1'-0" high x 2" deep spall.
P-36N-2	Pier 36N, North Face, Pedestal 5	2'-9" wide x 7" high x 2" deep spall.
P-36N-3	Pier 36N, East Face, Pedestal 5	1'-6" wide x 5" high x 1 1/2" deep spall.
P-36N-4	Pier 36N, East Face, Pedestal 5	2'-7" long x 1/4" wide horizontal crack.
P-36N-5	Pier 36N, East Face, Column 2	3" wide x 4" high x 2" deep spall.
P-37N-1	Pier 37N, West Face, Pedestal 1	7" wide x 3" high x 1" deep spall.
P-38N-1	Pier 38N, North Face, Pedestal 5	1'-5" wide x 6" high area of delaminated concrete.
P-38N-2	Pier 38N, West Face, Pedestal 6	2'-0" wide x 9 1/2" high x 2" deep spall with exposed steel reinforcement.
P-39N-1	Pier 39N, East Face, Pedestal 3	1'-4" wide x 5" high area of delaminated concrete.
P-39N-2	Pier 39N, West Face, Pedestal 4	1'-4" wide x 3" high x 1" deep spall.
P-39N-3	Pier 39N, West Face, Pedestal 6	1'-0" wide x 5" high area of delaminated concrete.

Bridge 1-748N: Substructure Defects (Continued)

Defect Number	Location	Description
P-41N-1	Pier 41N, East Face Pedestal 4	9" wide x 7" high x 1/2" deep spall with exposed and corroded steel reinforcement.
P-41N-2	Pier 41N, East Face Pedestal 6	3'-2" long x 1/8" wide crack with corrosion staining.
P-44N-1	Pier 44N, North Face, Column 1	1'-6" wide x 4'-1" long area of delaminated concrete.
P-44N-2	Pier 44N, North Face, Column 1	6" wide x 5" high x 1/2" deep spall.
P-44N-3	Pier 44N, East Face, Pedestal 3	6" wide x 5" long x 1/2" deep spall.
P-44N-4	Pier 44N, West Face, Column 1	8" wide x 4'-1" long area of delaminated concrete.
P-45N-1	Pier 45N, Underside, Pier Cap	7" wide x 1'-0" long area of delaminated concrete.
P-45N-2	Pier 45N, Underside, Pier Cap	9" wide x 1'-4" long area of delaminated concrete at east overhang.
P-46N-1	Pier 46N, Northwest Corner, Column 1	1'-9" wide x 3'-0" long area of delaminated concrete.
P-46N-2	Pier 46N, Northeast Corner, Column 1	1'-10" wide x 2'-1" long area of delaminated concrete.
P-46N-3	Pier 46N, Northwest Corner, Column 2	9" wide x 1'-8" long area of delaminated concrete.
P-46N-4	Pier 46N, North Face, Pedestal 3	1'-2 1/2" wide x 3'-2" long x 3" deep spall.
P-46N-5	Pier 46N, North Face, Pedestal 4	1'-3" wide x 2'-5" long x 2 1/2" deep spall.
P-46N-6	Pier 46N, East Face, Pedestal 1	6" wide x 1'-5" long area of delaminated concrete.
P-46N-7	Pier 46N, East Face, Pedestal 4	9" wide x 2'-4" long area of delaminated concrete.
P-46N-8	Pier 46N, East Face, Pedestal 4	4" wide x 10" long x 2" deep spall.
P-46N-9	Pier 46N, East Face, Pedestal 5	1'-1 1/2" wide x 3'-5" long area of delaminated concrete.
P-46N-10	Pier 46N, East Face, Pedestal 6	1'-10" long x 1/16" wide crack.

Bridge 1-748N: Substructure Defects (Continued)

Defect Number	Location	Description
P-46N-11	Pier 46N, South Face, Pier Cap	6" wide x 4'-4" long area of delaminated concrete.
P-46N-12	Pier 46N, South Face, Pier Cap	8" wide x 1'-3" long area of delaminated concrete.
P-46N-13	Pier 46N, South Face, Pier Cap	1'-4" wide x 1'-1" long x 1" deep spall.
P-46N-14	Pier 46N, South Face, Pier Cap	1'-7" wide x 2'-3" long x 4" deep spall.
P-46N-15	Pier 46N, South Face, Column 2	7 1/2" wide x 11" high area of delaminated concrete.
P-46N-16	Pier 46N, South Face, Column 2	1'-6" wide x 3'-7" high x 3 1/2" deep spall with exposed steel reinforcement.
P-46N-17	Pier 46N, South Face, Pedestal 5	1'-6" long x 1/16" wide diagonal crack.
P-46N-18	Pier 46N, South Face, Pedestal 6	1'-5" wide x 4" wide area of delaminated concrete with 1/16" wide perimeter cracking.
P-46N-19	Pier 46N, Underside, Pier Cap	1'-4" wide x 1'-5" long area of delaminated concrete
P-46N-20	Pier 46N, Underside, Pier Cap	3'-0" wide x 2'-9" long area of delaminated concrete.
P-46N-21	Pier 46N, Underside, Pier Cap	1'-3" wide x 1'-3" long area of delaminated concrete at east overhang.
P-46N-22	Pier 46N, Top, Pier Cap	1'-7" wide x 4'-4" long area of delaminated concrete.
P-46N-23	Pier 46N, Top, Pier Cap	1'-10" wide x 1'-5" long area of delaminated concrete.
P-47N-1	Pier 47N, North Face, Column 1	1'-4" long x 1/8" wide vertical crack.
P-47N-2	Pier 47N, North Face, Column 2	2'-4" wide x 1'-6" high area of delaminated concrete.
P-47N-3	Pier 47N, Underside, Pier Cap	1'-3" wide x 1'-10" long area of delaminated concrete at west overhang.
P-48N-1	Pier 48N, North Face, Column 1	2'-5" wide x 1'-8" high area of delaminated concrete.
P-48N-2	Pier 48N, North Face, Column 2	1'-9" wide x 2'-6" high x 4" deep spall with exposed and corroded steel reinforcement.

Bridge 1-748N: Substructure Defects (Continued)

Defect Number	Location	Description
P-48N-3	Pier 48N, North Face, Pedestal 3	6" wide x 3" high x 1/2" deep spall with exposed and corroded steel reinforcement.
P-48N-4	Pier 48N, North Face, Pedestal 3	8" wide x 6" high x 1" deep spall with exposed and corroded steel reinforcement.
P-48N-5	Pier 48N, East Face, Pedestal 1	11" wide x 4" high x 1/2" deep spall with exposed and corroded steel reinforcement.
P-48N-6	Pier 48N, East Face, Pedestal 4	1'-8" wide x 7" high area of delaminated concrete.
P-48N-7	Pier 48N, East Face, Pedestal 6	9" wide x 8" high area of delaminated concrete.
P-48N-8	Pier 48N, West Face, Pedestal 3	7" wide x 3" high x 1" deep spall.
P-49N-1	Pier 49N, South Face, Column 1	1'-6" long x 1/4" wide vertical crack.
P-49N-2	Pier 49N, South Face, Column 1	2" wide x 9" long area of delaminated concrete.
P-49N-3	Pier 49N, West Face, Column 1	2'-6" long x 1/16" wide vertical crack with associated efflorescence.
P-49N-4	Pier 49N, West Face, Pedestal 2	8" wide x 7" long x 1" deep corner spall.
P-50N-1	Pier 50N, South Face, Column 1	3" wide x 6" long x 1/2" deep spall.
P-50N-2	Pier 50N, East Face, Pedestal 3	1'-0" wide x 1'-9" long x 8" deep spall with exposed reinforcement.
P-51N-1	Pier 51N, West Face, Column 1	8" wide x 9" long area of delaminated concrete.
P-51N-2	Pier 51N, South Face, Pedestal 2	6" wide x 9" long x 1/2" deep spall.
P-52N-1	Pier 52N, East Face, Pier Cap	1'-6" long x 1/16" wide crack.
P-52N-2	Pier 52N, East Face, Pedestal 10	3'-4" long x 1/8" wide crack.
P-52N-3	Pier 52N, South Face, Pedestal 3	7" wide x 2'-5" long x 1 1/2" deep spall.
P-52N-4	Pier 52N, South Face, Pier Cap	1'-2" wide x 1'-11" long area of delaminated concrete.

Bridge 1-748N: Substructure Defects (Continued)

Defect Number	Location	Description
P-53N-1	Pier 53N, North Face, Pier Cap	1'-11" long x 1/16" wide crack.
P-53N-2	Pier 53N, North Face, Pier Cap	6'-6" long x 1/16" wide crack.
P-53N-3	Pier 53N, North Face, Pier Cap	4" wide x 1'-2" long area of delaminated concrete.
P-53N-4	Pier 53N, North Face, Pier Cap	6" wide x 8" long area of delaminated concrete.
P-53N-5	Pier 53N, Northeast Corner, Pedestal 9	4'-10" long x 1/16" wide crack.
P-53N-6	Pier 53N, East Face, Pedestal 2	3'-3" long x 1/16" wide crack.
P-53N-7	Pier 53N, South Face, Pier Cap	2'-0" long x 1/18" wide crack.
P-53N-8	Pier 53N, South Face, Pier Cap	2'-0" long x 1/18" wide crack with corrosion staining.
P-53N-9	Pier 53N, South Face, Pier Cap	6'-6" long x 1/16" wide crack.
P-53N-10	Pier 53N, South Face, Pier Cap	4'-0" long x 1/16" wide crack.
P-53N-11	Pier 53N, South Face, Pier Cap	1'-8" wide x 4'-7" long area of delaminated concrete.
P-53N-12	Pier 53N, South Face, Column 2	1'-7" wide x 1'-9" long x 1" deep spall with exposed steel reinforcement.
P-53N-13	Pier 53N, Southeast corner, Column 2	1'-1/2" wide x 2'-6" long area of delaminated concrete.
P-53N-14	Pier 53N, Southeast Corner, Column 3	9" wide x 1'-4" long area of delaminated concrete.
P-53N-15	Pier 53N, South Face, Column 3	1'-2" wide x 6'-0" long area of delaminated concrete.
P-53N-16	Pier 53N, South Face, Column 3	11" wide x 2'-9" long area of delaminated concrete at mid-height.
P-53N-17	Pier 53N, South Face, Pedestal 3	6" wide x 1'-10" long x 2 1/2" deep spall.
P-53N-18	Pier 53N, South Face, Pedestal 7	2'-0" long x 1/16" wide crack.

Bridge 1-748N: Substructure Defects (Continued)

Defect Number	Location	Description
P-53N-19	Pier 53N, Underside, Pier Cap	9" wide x 11" long x 1" deep spall.
P-53N-20	Pier 53N, Underside, Pier Cap	9" wide x 1'-1" long area of delaminated concrete between Columns 1 and 2.
P-53N-21	Pier 53N, Underside, Pier Cap	1'-0" wide x 9" long x 1/2" deep spall with exposed steel reinforcement between Columns 1 and 2.
P-53N-22	Pier 53N, Underside, Pier Cap	1'-0" wide x 7" long x 1/2" deep spall with exposed steel reinforcement between Columns 1 and 2.
P-53N-23	Pier 53N, Underside, Pier Cap	10" wide x 1'-3" long x 1" deep spall with exposed steel reinforcement between Columns 1 and 2.
P-53N-24	Pier 53N, Underside, Pier Cap	1'-10" wide x 1'-10" long area of delaminated concrete between Columns 1 and 2.
P-53N-25	Pier 53N, Underside, Pier Cap	5 1/2" wide x 1'-6" long area of delaminated concrete between Columns 2 and 3.
P-53N-26	Pier 53N, Top Face, Pier Cap	8" wide x 8" long x 3/4" deep spall between Pedestals 7 and 8.
P-53N-27	Pier 53N, Top Face, Pier Cap	Debris accumulation up to 2" deep throughout.
P-54N-1	Pier 54N, North Face, Pier Cap	1'-10" wide x 3'-7" long area of delaminated concrete.
P-54N-2	Pier 54N, Underside, Pier Cap	9" wide x 3'-7" long area of delaminated concrete.
P-54N-3	Pier 54N, South Face, Pier Cap	6" wide x 8" long area of delaminated concrete.
P-54N-4	Pier 54N, South Face, Pier Cap	3'-8" wide x 4'-4" long area of delaminated concrete.
P-54N-5	Pier 54N, Top Face, Pier Cap	Debris accumulation up to 2" deep throughout.
P-55N-1	Pier 54N, North Face, Pier Cap	2" wide x 8" long x 1/4" deep spall.
P-55N-2	Pier 55N, North Face, Column 1	1'-1" wide x 1'-2" long area of delaminated concrete.
P-55N-3	Pier 55N, North Face, Pier Cap	10" wide x 11" long area of delaminated concrete.
P-55N-4	Pier 55N, North Face, Column 2	3'-3" wide x 2'-4" long area of delaminated concrete.

Bridge 1-748N: Substructure Defects (Continued)

Defect Number	Location	Description
P-55N-5	Pier 55N, Northeast Corner, Pedestal 2	1'-0" wide x 11" long x 1 1/2" deep spall.
P-55N-6	Pier 55N, East Face, Column 3	6" wide x 1'-3" long x area of delaminated concrete.
P-55N-7	Pier 55N, East Face, Pier Cap	1'-0" wide x 2'-6" long x up to 1/2" deep spall.
P-55N-8	Pier 55N, East Face, Pedestal 3	1'-0" wide x 1'-1" long x 4" deep spall with exposed steel reinforcement.
P-55N-9	Pier 55N, East Face, Pedestal 4	2'-0" long x 1/16" wide crack.
P-55N-10	Pier 55N, East Face, Pedestal 5	10" wide x 2'-11" long x 2" deep spall.
P-55N-11	Pier 55N, East Face, Pedestal 8	1'-3" wide x 3'-3" long x 2" deep spall.
P-55N-12	Pier 55N, South Face, Pier Cap	4'-0" long x 1/16" wide crack.
P-55N-13	Pier 55N, South Face, Pier Cap	7" wide x 9" long area of delaminated concrete.
P-55N-14	Pier 55N, South Face, Pier Cap	8" wide x 1'-1" long area of delaminated concrete.
P-55N-15	Pier 55N, South Face, Pier Cap	8" wide x 2'-3" long area of delaminated concrete.
P-55N-16	Pier 55N, South Face, Pier Cap	5" wide x 9" long area of delaminated concrete.
P-55N-17	Pier 55N, South Face, Pier Cap	6" wide x 1'-10" long x 6" wide area of delaminated concrete.
P-55N-18	Pier 55N, South Face, Pier Cap	1'-2" wide x 1'-6" long x 1'-2" area of delaminated concrete.
P-55N-19	Pier 55N, South Face, Pier Cap	2" wide x 9" long x 1/4" deep spall.
P-55N-20	Pier 55N, South Face, Column 1	1'-1" wide x 1'-9" long area of delaminated concrete.
P-55N-21	Pier 55N, South Face, Column 1	1'-8" wide x 2'-11" long area of delaminated concrete.
P-55N-22	Pier 55N, South Face, Column 2	7" wide x 1'-0" long area of delaminated concrete.

Bridge 1-748N: Substructure Defects (Continued)

Defect Number	Location	Description
P-55N-23	Pier 55N, South Face, Pedestal 2	10" wide x 1'-5" long x 4" deep spall with exposed steel reinforcement.
P-55N-24	Pier 55N, South Face, Pedestal 4	1'-1" long x 1/8" wide crack.
P-55N-25	Pier 55N, South Face, Pedestal 5	9" long x 1/16" wide crack.
P-55N-26	Pier 55N, Southwest Corner, Column 3	10" wide x 3'-2" long x 2 1/2" deep spall.
P-55N-27	Pier 55N, West Face, Column 2	3'-0" long x 1/8" wide crack.
P-55N-28	Pier 55N, Underside, Pier Cap	4'-4" long x 1/16" wide crack between Columns 1 and 2.
P-55N-29	Pier 55N, Underside, Pier Cap	2'-0" long x 1/16" wide crack between Columns 1 and 2.
P-55N-30	Pier 55N, Underside, Pier Cap	1'-5" wide x 2'-6" long area of delaminated concrete between Columns 1 and 2.
P-55N-31	Pier 55N, Underside, Pier Cap	1'-0" wide x 1'-3" long area of delaminated concrete between Columns 1 and 2.
P-55N-32	Pier 55N, Underside, Pier Cap	1'-0" wide x 1'-7" long area of delaminated concrete between Columns 2 and 3.
P-55N-33	Pier 55N, Underside, Pier Cap	1'-6" wide x 2'-1" long area of delaminated concrete between Columns 2 and 3.
P-55N-34	Pier 55N, Underside, Pier Cap	1'-2" wide x 2'-2" long area of delaminated concrete between Columns 2 and 3.
P-55N-35	Pier 55N, Underside, Pier Cap	2'-5" wide x 4'-5" long area of delaminated concrete at the east overhang.
P-56N-1	Pier 56N, East Face, Pedestal 8	3'-0" long x 1/16" wide crack.
P-56N-2	Pier 56N, South Face, Column 1	1'-0" wide x 1'-9" long area of delaminated concrete.
P-56N-3	Pier 56N, Top Face, Pier Cap	11" wide x 3'-2" long area of delaminated concrete between Pedestals 7 and 8.
P-57N-1	Pier 57N, North Face, East Pier Cap	2'-4" wide x 2'-2" high area of delaminated concrete with 2'-0" long x 1/16" wide crack.
P-57N-2	Pier 57N, South Face, Pier Cap	6" wide x 2'-7" long area of delaminated concrete.

Bridge 1-748N: Substructure Defects (Continued)

Defect Number	Location	Description
P-57N-3	Pier 57N, South Face, Pedestal 7	7" wide x 10" long x 1" deep spall.
P-57N-4	Pier 57N, Underside, Pier Cap	2'-0" wide x 2'-0" long area of delaminated concrete at east overhang.
P-57N-5	Pier 57N, Top Face, Pier Cap	9" wide x 1'-0" long area of delaminated concrete between Pedestals 1 and 2.
P-57N-6	Pier 57N, Top Face, Pier Cap	3'-5" long x 1/4" wide crack between Pedestals 7 and 8.
P-58N-1	Pier 58N, North Face, Pier Cap	9" wide x 1'-9" long area of delaminated concrete.
P-58N-2	Pier 58N, East Face, Pedestal 2	8" wide x 1'-0" long x 1" deep spall with exposed steel reinforcement.
P-58N-3	Pier 58N, Top Face, Pier Cap	1'-0" wide x 2'-3" long x 2" deep spall at east overhang.
P-58N-4	Pier 58N, Southwest Corner, Column 3	1'-2" wide x 2'-4" long area of delaminated concrete.
P-58N-5	Pier 58N, Underside, Pier Cap	2'-0" wide x 2'-4" long x 2'-0" wide x 2" deep spall at west overhang.
P-59N-1	Pier 59N, North Face, Pier Cap	2'-9" wide x 4'-2" long area of delaminated concrete with associated 4'-2" long x 1/4" wide crack on bottom face.
P-59N-2	Pier 59N, East Face, Pedestal 3	8 1/2" wide x 6" high area of delaminated concrete.
P-59N-3	Pier 59N, South Face, Pier Cap	1'-1" wide x 1'-2" long area of delaminated concrete.
P-59N-4	Pier 59N, Pier Cap, South Face	3'-0" long x 1/8" wide crack in pier cap.
A-60N-1	North Abutment Backwall, Bay 1	3'-0" high x 1/16" wide crack.
A-60N-2	North Abutment Backwall, Bay 2	3'-0" high x 1/16" wide crack.
A-60N-3	North Abutment Backwall, Bay 3	5'-0" long (full-height) x 1/8" wide crack.
A-60N-4	North Abutment Backwall, Bay 4	5'-0" long (full-height) x 1/8" wide crack.
A-60N-5	North Abutment, Pedestal 4	6" wide x 1'-0" long area of delaminated concrete.

Bridge 1-748N: Substructure Defects (Continued)

Defect Number	Location	Description
A-60N-6	North Abutment, Top Face, Pedestal 4	1'-6" wide x 2'-6" long area of delaminated concrete.
A-60N-7	North Abutment, Backwall, Bay 8	2'-0" wide x 3'-0" long area of delaminated concrete.

Bridge 1-748S: Substructure Defects

Defect Number	Location	Description
P-27S-1	Pier 27S, North Face, Pier Cap	2'-0" wide x 1'-3" high area of delaminated concrete.
P-27S-2	Pier 27S, North Face, Pier Cap	1'-8" wide x 10" high area of delaminated concrete.
P-27S-3	Pier 27S, West Face, Pedestal 4	3'-5" wide x 1'-2" high x 6" deep spall with exposed steel reinforcement.
P-27S-4	Pier 27S, Underside, Pier Cap	1'-3" wide x 1'-5" long area of delaminated concrete.
P-27S-5	Pier 27S, Underside, Pier Cap	1'-0" wide x 1'-3" long area of delaminated concrete.
P-28S-1	Pier 28S, North Face, Column 3	10" wide x 9" high x 1" deep spall with exposed steel reinforcement.
P-28S-2	Pier 28S, South Face, Column 2	1'-5" wide x 1'-5" high x 1 1/2" deep spall.
P-29S-1	Pier 29S, Northwest Corner, Column 1	6" wide x 10" high x 2" deep spall.
P-29S-2	Pier 29S, Column 1, Drainage	Downspout coupler at the base of the column is disconnected and downspout is clogged.
P-30S-1	Pier 30S, North Face, Pier Cap	2'-9" long x 1/16" wide horizontal crack.
P-30S-2	Pier 30S, North Face, Pier Cap	1'-10" long x 1/16" wide horizontal crack.
P-30S-3	Pier 30S, North Face, Pier Cap	3'-11" long x 1/8" wide horizontal crack.
P-30S-4	Pier 30S, North Face, Pier Cap	11" wide x 11" high area of delaminated concrete.
P-30S-5	Pier 30S, North Face, Pedestal 1	8" long x 1/16" wide horizontal crack.
P-30S-6	Pier 30S, East Face, Column 1	2'-0" long x 1/16" wide vertical crack with corrosion staining.
P-30S-7	Pier 30S, South Face, Pier Cap	1'-5" wide x 10" high area of delaminated concrete.
P-30S-8	Pier 30S, South Face, Column 1	5" wide x 1'-5" high area of delaminated concrete.
P-30S-9	Pier 30S, South Face, Pedestal 1	9 1/2" wide x 1'-1" high area of delaminated concrete.
P-30S-10	Pier 30S, West Face, Pedestal 1	6" wide x 9" high x 3" deep spall with exposed steel reinforcement.
P-30S-11	Pier 30S, West Face, Pedestal 1	7" wide x 5" high area of delaminated concrete.
P-30S-12	Pier 30S, Underside, Pier Cap	1'-2" long x 1/16" wide crack at west overhang.
P-30S-13	Pier 30S, Underside, Pier Cap	2'-5" long x 1/16" wide crack with corrosion staining.

Bridge 1-748S: Substructure Defects (Continued)

Defect Number	Location	Description
P-30S-14	Pier 30S, West Face, Pier Cap	1'-4" wide x 11 1/2" long area of delaminated concrete.
P-30S-15	Pier 30S, Underside, Pier Cap	1'-6" wide x 1'-8" long area of delaminated concrete.
P-30S-16	Pier 30S, Underside, Pier Cap	9" wide x 7" long area of delaminated concrete.
P-31S-1	Pier 31S, North Face, Pier Cap	2'-10" wide x 8" high area of delaminated concrete.
P-31S-2	Pier 31S, North Face, Column 1	9" wide x 1'-9" high area of delaminated concrete.
P-31S-3	Pier 31S, North Face, Column 1	2'-10" wide x 1'-10" high x 3" deep spall with exposed steel reinforcement.
P-31S-4	Pier 31S, Northeast Corner, Pedestal 2	1'-2" wide x 1'-2" long area of delaminated concrete.
P-31S-5	Pier 31S, South Face, Pier Cap	3'-10" long x 1/8" wide horizontal crack with corrosion staining.
P-31S-6	Pier 31S, South Face, Pier Cap	4'-11" wide x 3" high area of delaminated concrete with 1/8" wide horizontal crack.
P-31S-7	Pier 31S, South Face, Pedestal 3	6" wide x 6" high area of delaminated concrete.
P-31S-8	Pier 31S, West Face, Pier Cap	1'-5" wide x 4" high area of delaminated concrete with 1/16" wide perimeter crack.
P-31S-9	Pier 31S, Underside, Pier Cap	3'-3" long x 3/32" wide crack with corrosion staining between Columns 1 and 2.
P-31S-10	Pier 31S, Underside, Pier Cap	1'-6" wide x 11" long area of delaminated concrete between Columns 1 and 2.
P-31S-11	Pier 31S, Underside, Pier Cap	1'-5" wide x 1'-0" long x 1 1/2" deep spall with exposed steel reinforcement between Columns 1 and 2.
P-31S-12	Pier 31S, Underside, Pier Cap	1'-9" wide x 2'-0" long area of delaminated concrete between Columns 1 and 2.
P-31S-13	Pier 31S, Underside, Pier Cap	1'-8" wide x 4'-6" long area of delaminated concrete between Columns 2 and 3.
P-31S-14	Pier 31S, Underside, Pier Cap	2'-3" wide x 2'-5" long area of delaminated concrete between Columns 2 and 3.
P-32S-1	Pier 32S, North Face, Pier Cap	3'-0" long x 1/16" wide horizontal crack.
P-32S-2	Pier 32S, North Face, Pier Cap	2'-6" long x 1/16" wide horizontal crack.
P-32S-3	Pier 32S, North Face, Pier Cap	2'-5" long x 1/18" wide horizontal crack.
P-32S-4	Pier 32S, North Face, Pier Cap	4" wide x 7" high area of delaminated concrete.
P-32S-5	Pier 32S, North Face, Pier Cap	2'-9" wide x 8 1/2" high area of delaminated concrete.

Bridge 1-748S: Substructure Defects (Continued)

Defect Number	Location	Description
P-32S-6	Pier 32S, North Face, Pier Cap/Column 1	1'-4" wide x 3'-0" high area of delaminated concrete.
P-32S-7	Pier 32S, North Face, Pier Cap	3'-10" wide x 2'-7" high x 1" deep spall at west overhang.
P-32S-8	Pier 32S, East Face, Column 1	1'-5" long x 1/16" wide vertical crack.
P-32S-9	Pier 32S, South Face, Pier Cap	10'-0" long x 1/16" wide horizontal crack with corrosion staining.
P-32S-10	Pier 32S, South Face, Pier Cap	1'-2" long x 1/16" wide horizontal crack.
P-32S-11	Pier 32S, South Face, Pier Cap	2'-0" long x 1/16" wide horizontal crack with corrosion staining.
P-32S-12	Pier 32S, South Face, Pier Cap	1'-8" wide x 1'-4" high area of delaminated concrete.
P-32S-13	Pier 32S, South Face, Column 1	6" wide x 6" high area of delaminated concrete.
P-32S-14	Pier 32S, Underside, Pier Cap	10" wide x 2'-10" long area of delaminated concrete at west overhang.
P-32S-15	Pier 32S, Underside, Pier Cap	7" wide x 2'-10" long area of delaminated concrete at west overhang.
P-32S-16	Pier 32S, Top Face, Pier Cap	1'-0" wide x 3'-0" long x 1" deep spall between Pedestals 1 and 2.
P-33S-1	Pier 33S, North Face, Pier Cap	3" wide x 3" high x 1/2" deep spall with exposed and corroded steel reinforcement.
P-33S-2	Pier 33S, South Face, Pier Cap	1'-3" wide x 22" high x 1 1/2" deep spall with exposed steel reinforcement.
P-33S-3	Pier 33S, South Face, Pier Cap	7" wide x 1'-3" high area of delaminated concrete.
P-33S-4	Pier 33S, South Face, Pier Cap	9" wide x 1'-0" high area of delaminated concrete.
P-33S-5	Pier 33S, South Face, Pier Cap	4" wide x 3" high x 1/2" deep spall with exposed and corroded steel reinforcement.
P-33S-6	Pier 33S, South Face, Column 2	2" wide x 2" high x 1/2" deep spall with exposed and corroded steel reinforcement.
P-33S-7	Pier 33S, Top Face, Pier Cap	1'-4" wide x 1'-7" long area of delaminated concrete between Pedestals 9 and 10.
P-34S-1	Pier 34S, East Face, Pedestal 5	1'-0" wide x 9" high x 1" deep spall with exposed and corroded steel reinforcement.
P-34S-2	Pier 34S, Underside, Pier Cap	3'-4" wide x 3'-11" long area of delaminated concrete at east overhang.
P-34S-3	Pier 34S, Column 2, Drainage	Downspout coupler at the base of the column is disconnected.
P-34S-4	Pier 34S, Top Face, Pier Cap	Random areas of debris up to 2" deep.

Bridge 1-748S: Substructure Defects (Continued)

Defect Number	Location	Description
P-35S-1	Pier 35S, Top Face, Pier Cap	9" wide x 1'-0" long area of delaminated concrete at east overhang.
P-36S-1	Pier 36S, East Face, Pier Cap	4" wide x 6" high x 1/4" deep spall with exposed and corroded steel reinforcement.
P-36S-1	Pier 36S, East Face, Pier Cap	4" wide x 6" high x 1/4" deep spall with exposed and corroded steel reinforcement.
P-36S-3	Pier 36S, Underside, Pier Cap	1'-0" wide x 1'-3" long area of delaminated concrete between Columns 1 and 2.
P-36S-4	Pier 36S, Underside, Pier Cap	1'-6" wide x 1'-10" long x 1" deep spall at east overhang.
P-36S-5	Pier 36S, Top Face, Pier Cap	8" wide x 2'-11" long area of delaminated concrete.
P-36S-6	Pier 36S, Top Face, Pier Cap	4'-2" long x 1/8" wide crack.
P-37S-1	Pier 37S, North Face, Column 2	8" wide x 1'-2" high area of delaminated concrete.
P-37S-2	Pier 37S, East Face, Pedestal 1	1'-11" wide x 1'-4" long x 3/4" deep corner spall with exposed and corroded steel reinforcement.
P-37S-3	Pier 37S, East Face, Pedestal 5	6" wide x 4" high x 1/2" deep spall with exposed and corroded steel reinforcement.
P-37S-4	Pier 37S, South Face, Pier Cap	2'-6" long x 1/16" wide horizontal crack.
P-38S-1	Pier 38S, West Face, Pedestal 3	1'-9" wide x 7" high area of delaminated concrete.
P-38S-2	Pier 38S, East Face, Pedestal 6	1'-5" wide x 11" high area of delaminated concrete.
P-39S-1	Pier 39S, East Face, Pedestal 1	1'-5" wide x 4" high x 1/4" deep spall.
P-40S-1	Pier 40S, North Face, Pier Cap	7" wide x 1'-2" high area of delaminated concrete.
P-40S-2	Pier 40S, North Face, Column 1	9" wide x 10" high x 1" deep spall.
P-40S-3	Pier 40S, East Face, Pedestal 1	1'-4" wide x 6" high x 1/2" deep spall with exposed and corroded steel reinforcement.
P-41S-1	Pier 41S, East Face, Pedestal 1	3'-4" wide x 9" high x 6" deep spall with exposed and corroded steel reinforcement.
P-42S-1	Pier 42S, West Face, Pier Cap	2'-2" wide x 10" high x 3" deep corner spall.
P-43S-1	Pier 43S, East Face, Pedestal 3	1'-4" wide x 6" high area of delaminated concrete.
P-43S-2	Pier 43S, South Face, Column 1	10" wide x 1'-7" high area of delaminated concrete.
P-43S-3	Pier 43S, South Face, Pedestal 6	1'-0" long x 1/16" wide horizontal crack with corrosion staining.

Bridge 1-748S: Substructure Defects (Continued)

Defect Number	Location	Description
P-43S-4	Pier 43S, West Face, Pedestal 6	1'-6" long x 3/32" wide horizontal crack with corrosion staining.
P-43S-5	Pier 43S, West Face, Pedestal 6	2'-0" wide x 6" high area of delaminated concrete.
P-44S-1	Pier 44S, Southwest Corner, Column 1	1'-0" wide x 2'-5" high area of delaminated concrete.
P-44S-2	Pier 44S, South Face, Pier Cap	2'-2" wide x 11" high area of delaminated concrete.
P-44S-3	Pier 44S, Column 2, Drainage	Downspout coupler at the base of the column is disconnected.
P-45S-1	Pier 45S, Northeast Corner, Column 2	1'-2" wide x 2'-11" high area of delaminated concrete.
P-45S-2	Pier 45S, Underside, Pier Cap	11" wide x 3'-11" long area of delaminated concrete at east overhang.
P-45S-3	Pier 45S, East Face, Pier Cap	1'-0" wide x 5 1/2" high x 1" deep spall.
P-45S-4	Pier 45S, Southeast Corner, Column 2	1'-0" wide x 2'-2" high area of delaminated concrete.
P-45S-5	Pier 45S, South Face, Pier Cap	2'-5" wide x 2'-9" high area of delaminated concrete.
P-45S-6	Pier 45S, West Face, Pedestal 1	2" wide x 2" high x 1/2" deep spall with exposed and corroded steel reinforcement.
P-45S-7	Pier 45S, Underside, Pier Cap	15" wide x 15" long x 1/2" deep spall between Columns 1 and 2.
P-45S-8	Pier 45S, Top Face, Pier Cap	Debris accumulation up to 4" deep throughout.
P-46S-1	Pier 46S, North Face, Pier Cap	3'-0" wide x 3 1/2" high area of delaminated concrete with 1/16" wide horizontal cracking.
P-46S-2	Pier 46S, North Face, Pier Cap	5" wide x 8" high area of delaminated concrete.
P-46S-3	Pier 46S, North Face, Pedestal 4	3'-6" wide x 10" high area of delaminated concrete.
P-46S-4	Pier 46S, Northeast Corner, Pedestal 4	1'-0" wide x 10" high x 3" deep corner spall.
P-46S-5	Pier 46S, Northeast Corner, Pedestal 6	2'-7" wide x 10 1/2" high area of delaminated concrete.
P-46S-6	Pier 46S, North Face, Pedestal 6	1'-3" wide x 7" high x 1/2" deep spall.
P-46S-7	Pier 46S, East Face, Pedestal 1	3'-4" wide x 1'-3" high x 2" deep spall.
P-46S-8	Pier 46S, East Face, Pedestal 4	2'-6" wide x 8" high x 3/4" deep spall with exposed steel reinforcement.
P-46S-9	Pier 46S, South Face, Column 2	11" wide x 1'-10" high area of delaminated concrete.

Bridge 1-748S: Substructure Defects (Continued)

Defect Number	Location	Description
P-46S-10	Pier 46S, South Face, Pier Cap	3'-4" wide x 1'-11" high area of delaminated concrete with 1/8" wide cracking.
P-46S-11	Pier 46S, Underside, Pier Cap	1'-6" wide x 2'-1" long area of delaminated concrete between Columns 1 and 2.
P-46S-12	Pier 46S, Underside, Pier Cap	9" wide x 11" long area of delaminated concrete between Columns 1 and 2.
P-46S-13	Pier 46S, Underside, Pier Cap	9" wide x 1'-7" long area of delaminated concrete between Columns 1 and 2.
P-46S-14	Pier 46S, Underside, Pier Cap	11" wide x 2'-6" long area of delaminated concrete between Columns 1 and 2.
P-46S-15	Pier 46S, Underside, Pier Cap	1'-2" wide x 1'-5" long area of delaminated concrete between Columns 1 and 2.
P-46S-16	Pier 46S, Underside, Pier Cap	2'-9" wide x 2'-11" long x 2" deep spall with exposed steel reinforcement.
P-46S-17	Pier 46S, Top Face, Pier Cap	9" wide x 9" long area of delaminated concrete between Pedestals 1 and 2.
P-46S-18	Pier 46S, Top Face, Pier Cap	1'-4" wide x 3'-0" long area of delaminated concrete between Pedestals 5 and 6.
P-47S-1	Pier 47S, North Face, Pier Cap	6'-5" wide x 7" high area of delaminated concrete with 1/16" perimeter cracking.
P-47S-2	Pier 47S, Northeast Corner, Column 1	1'-4" wide x 3'-5" high area of delaminated concrete with 1/16" vertical crack.
P-47S-3	Pier 47S, North Face, Column 1	9" wide x 1'-1" high area of delaminated concrete.
P-47S-4	Pier 47S, North Face, Pedestal 1	3" wide x 3" high x 1/2" deep spall with exposed steel reinforcement.
P-47S-5	Pier 47S, Northwest Corner, Pedestal 6	6 1/2" wide x 1'-3" high area of delaminated concrete with 1/32" wide perimeter cracking.
P-47S-6	Pier 47S, East Face, Pedestal 3	3'-3" wide x 10" high
P-47S-7	Pier 47S, Southeast Corner, Pedestal 4	1'-4" wide x 1'-0" high area of delamination.
P-47S-8	Pier 47S, South Face, Pier Cap	2'-6" long x 1/16" wide horizontal crack.
P-47S-9	Pier 47S, South Face, Pier Cap	8" wide x 7" high area of delaminated concrete.
P-47S-10	Pier 47S, South Face, Column 1	1'-1" wide x 2'-2" high area of delaminated concrete.
P-47S-11	Pier 47S, Southwest Corner, Column 1	11" wide x 1'-3" high area of delaminated concrete.
P-47S-12	Pier 47S, Southwest Corner, Column 1	10" wide x 1'-9" high x 3/4" deep area of severe scaling.
P-47S-13	Pier 47S, West Face, Pedestal 6	1'-2" wide x 6" high area of delaminated concrete.

Bridge 1-748S: Substructure Defects (Continued)

Defect Number	Location	Description
P-47S-14	Pier 47S, Underside, Pier Cap	3'-0" wide x 3'-1" long area of delaminated concrete between Columns 1 and 2.
P-47S-15	Pier 47S, Underside, Pier Cap	7" wide x 1'-5" long area of delaminated concrete between Columns 1 and 2.
P-47S-16	Pier 47S, Underside, Pier Cap	2'-6" wide x 2'-0" long area of delaminated concrete between Columns 1 and 2.
P-47S-17	Pier 47S, Underside, Pier Cap	1'-9" wide x 1'-9" long area of delaminated concrete between Columns 1 and 2.
P-47S-18	Pier 47S, Top Face, Pedestal 1	1'-6" long x 1/16" wide crack.
P-48S-1	Pier 48S, North Face, Column 1	1'-3" wide x 11" high area of delaminated concrete.
P-48S-2	Pier 48S, East Face, Pedestal 3	6" wide x 4" high x 1/2" deep spall.
P-48S-3	Pier 48S, East Face, Pedestal 6	9" wide x 7" high x 1/2" deep spall.
P-48S-4	Pier 48S, South Face, Pier Cap	1'-9" wide x 1'-5" high area of delaminated concrete.
P-48S-5	Pier 48S, West Face, Column 1	3" wide x 2" high x 1/2" deep spall with exposed steel reinforcement.
P-48S-6	Pier 48S, Top Face, Pier Cap	10" wide x 3'-4" long x 3/4" deep spall at the east overhang.
P-49S-1	Pier 49S, North Face, Pier Cap	3'-9" wide x 3'-3" high area of delaminated concrete.
P-49S-2	Pier 49S, South Face, Pier Cap	10" wide x 1'-0" high area of delaminated concrete.
P-49S-3	Pier 49S, South Face, Pier Cap	2'-6" wide x 4'-2" high x 1/2" deep spall.
P-49S-4	Pier 49S, South Face, Column 1	2'-4" wide x 4'-6" x 1" deep spall.
P-49S-5	Pier 49S, South Face, Column 1	7" wide x 2'-11" high area of delaminated concrete.
P-49S-6	Pier 49S, South Face, Column 1	8" wide x 1'-2" high area of delaminated concrete.
P-49S-7	Pier 49S, South Face, Column 1	1'-2" wide x 1'-2" high x 1" deep spall with exposed steel reinforcement.
P-49S-8	Pier 49S, Southwest Corner, Column 1	11" wide x 3'-8" high area of delaminated concrete.
P-49S-9	Pier 49S, Southwest Corner, Column 1	3'-2" wide x 4'-4" high area of delaminated concrete.
P-49S-10	Pier 49S, West Face, Column 1	2'-3" long x 1/16" wide vertical crack.
P-49S-11	Pier 49S, Underside, Pier Cap	2'-2" wide x 1'-10" long area of delaminated concrete between Columns 1 and 2.

Bridge 1-748S: Substructure Defects (Continued)

Defect Number	Location	Description
P-49S-12	Pier 49S, Underside, Pier Cap	6" wide x 6" long x 1/2" deep spall between Columns 1 and 2.
P-49S-13	Pier 49S, Underside, Pier cap	1'-0" wide x 1'-0" long area of delaminated concrete between Columns 1 and 2.
P-49S-14	Pier 49S, Top Face, Pier Cap	5'-0" long x 3/16" wide crack between Pedestals 1 and 2.
P-49S-15	Pier 49S, Top Face, Pedestal 1	5" wide x 2'-6" long x 1/2" deep spall.
P-50S-1	Pier 50S, East Face, Pedestal 5	2" wide x 1'-0" long x 1/4" deep crack.
P-51S-1	Pier 51S, North Face, Column 1	4" wide x 6" long x 1/2" deep spall.
P-51S-2	Pier 51S, West Face, Column 2	9" wide x 1'-2" long area of delaminated concrete.
P-52S-1	Pier 52S, East Face, Pedestal 1	11" wide x 2'-0" long x 2" deep spall with exposed steel reinforcement.
P-52S-2	Pier 52S, South Face, Pedestal 1	2" wide x 3" long x 1/2" deep spall.
P-52S-3	Pier 52S, South Face, Pedestal 1	7" wide x 4" long area of delaminated concrete.
P-52S-4	Pier 52S, West Face, Pedestal 6	6" wide x 10" long x 1/2" deep spall with exposed steel reinforcement.
P-52S-5	Pier 52S, Underside, Pier Cap	8" wide x 1'-0" long area of delaminated concrete.
P-52S-6	Pier 52S, Top Face, Pier Cap	1'-2" wide x 2'-4" long x 1" deep spall.
P-52S-7	Pier 52S, Top Face, Pier Cap	8" wide x 1'-0" long x 1" deep spall.
P-52S-8	Pier 52S, Top Face, Pedestal 4	6" wide x 6" long x 1/2" deep spall.
P-53S-1	Pier 53S, South Face, Column 2	6" wide x 3" long x 1/2" deep spall with exposed steel reinforcement.
P-54S-1	Pier 54S, Northeast Corner, Column 2	1'-0" wide x 1'-11" high area of delaminated concrete.
P-54S-2	Pier 54S, South Face, Pedestal 3	5" wide x 8" long x 1/4" deep spall.
P-54S-3	Pier 54S, West Face, Pedestal 6	10" wide x 2'-5" long area of delaminated concrete.
P-54S-4	Pier 54S, West Face, Pedestal 6	1'-0" wide x 3'-2" long x 4" deep spall with exposed steel reinforcement.
P-55S-1	Pier 55S, East Face, Pedestal 1	5" wide x 5" long x 1/2" deep spall.
P-55S-2	Pier 55S, Southeast Corner, Column 1	1'-1" wide x 1'-10" long area of delaminated concrete.

Bridge 1-748S: Substructure Defects (Continued)

Defect Number	Location	Description
P-55S-3	Pier 55S, South Face, Column 1	6" wide x 10" long area of delaminated concrete.
P-55S-4	Pier 55S, Underside, Pier Cap	8" wide x 8" long area of delaminated concrete at west overhang.
P-55S-5	Pier 55S, Top Face, Pier Cap	Moderate accumulation of debris in Bay 5.
P-56S-1	Pier 56S, North Face, Pier Cap	10" wide x 2'-11" long area of delaminated concrete.
P-56S-2	Pier 56S, South Face, Pier Cap	1'-0" wide x 2'-4" long area of delaminated concrete.
P-56S-3	Pier 56S, South Face, Pier Cap	5" wide x 1'-10" long area of delaminated concrete.
P-56S-4	Pier 56S, South Face, Pier Cap	3" wide x 2'-11" long area of delaminated concrete.
P-56S-5	Pier 56S, South Face, Pier Cap	5" wide x 1'-1" long x 1/2" deep spall.
P-56S-6	Pier 56S, Southwest Corner, Pedestal 2	1'-4 1/2" wide x 2'-6" long area of delaminated concrete.
P-56S-7	Pier 56S, South Face, Pedestal 5	7" wide x 7" long area of delaminated concrete.
P-56S-8	Pier 56S, Top Face, Pier Cap	4'-2" wide x 2'-11" long area of delaminated concrete between Pedestals 5 and 6.
P-56S-9	Pier 56S, Top Face, Pier Cap	1'-4" wide x 1'-4" long x 1" deep spall between Pedestals 3 and 4.
P-56S-10	Pier 56S, Top Face, Pier Cap	1'-0" wide x 1'-0" long x 1" deep spall between Pedestals 3 and 4.
P-57S-1	Pier 57S, East Face, Pier Cap	7" wide x 9" long x 1 1/2" deep spall.
P-57S-2	Pier 57S, South Face, Pier Cap	6" wide x 1'-6" long area of delaminated concrete.
P-57S-3	Pier 57S, Column 1, Drainage	Hopper near the top of cap is clogged and downspout coupler is disconnected at the base.
P-58S-1	Pier 58S, North Face, Column 1	3" wide x 3" high x 1/2" deep spall.
P-58S-2	Pier 58S, East Face, Pedestal 2	6" wide x 7" long area of delaminated concrete.
P-58S-3	Pier 58S, South Face, Pier Cap	11" wide x 1'-6" long area of delaminated concrete.
P-58S-4	Pier 58S, Underside, Pier Cap	1'-2" wide x 1'-9" long area of delaminated concrete at east overhang.
P-59S-1	Pier 59S, North Face, Pier Cap	2'-0" long x 1/16" wide crack.
P-59S-2	Pier 59S, Top Face, Pier Cap	4" wide x 1'-0" long area of delaminated concrete between Pedestals 5 and 6.

Bridge 1-748S: Substructure Defects (Continued)

Defect Number	Location	Description
A-60S-1	North Abutment, Southwest Corner, Pedestal 6	6" wide x 1'-0" long area of delaminated concrete.
A-60S-2	North Abutment, Backwall, Pedestal 6	1'-0" wide x 1'-0" long area of delaminated concrete with hairline cracks.
A-60S-3	North Abutment, West End, Slope Protection	Two (2) small trees are growing between the abutment and slope protection.

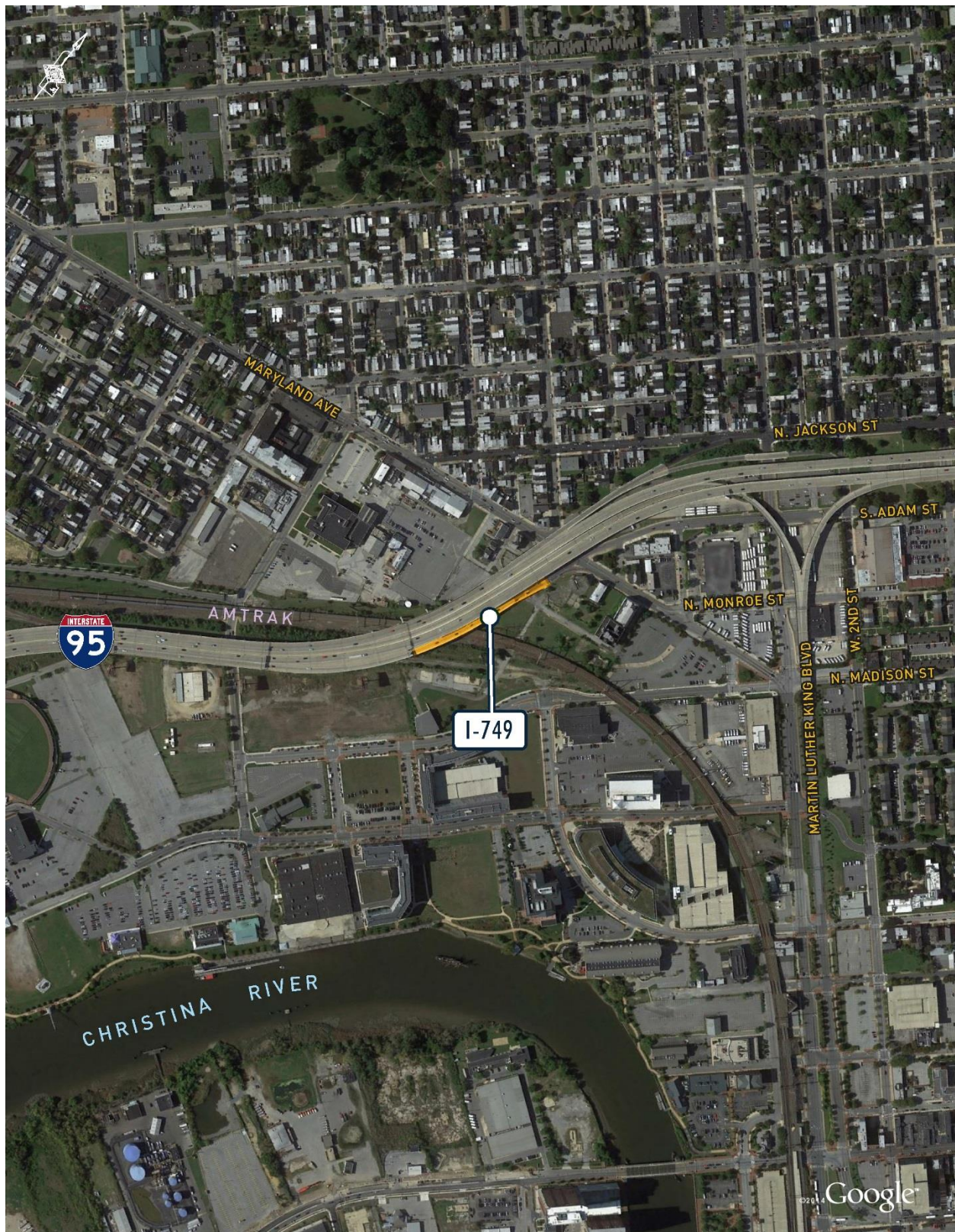
4.2 Bridge 1-749

4.2.1 Bridge Description

Bridge 1-749 (Ramp A) is a ramp from I-95 NB to SR 4 over Liberty St. and Amtrak (see Location Map in Section 4.2.2). The structure is a six (6) span simply supported steel beam bridge built in 1964 and widened in 1978. The bridge has an overall length of 609'-6"± with span lengths of 144'-7"±, 117'-0"±, 124'-7"±, 75'-2"±, 75'-2"± and 74'-0"±. The bridge has an out-to-out width that varies from 27'-2"± to 41'-3½" providing a clear roadway width that varies from 22'-0"± to 36'-1½"±. Four (4) spans of the bridge carry one (1) lane of traffic from I-95 NB and the widened two (2) spans (Spans 5 and 6) of the bridge carry three (3) lanes of traffic from I-95 NB to SR 4. The superstructure in Spans 1 – 3 consists of four (4) painted steel plate girders supporting a 7½"± thick reinforced concrete deck. The superstructure in Span 4 consists of four (4) painted steel rolled beams with welded cover plates supporting a 7½" reinforced concrete deck. The superstructure in Span 5 consists of five (5) painted steel rolled beams with welded cover plates supporting a 7½"± reinforced concrete deck. The superstructure in Span 6 consists of six (6) painted steel rolled beams with welded cover plates supporting a 7½"± reinforced concrete deck. According to plans, the existing deck is protected by a 2¼" thick LMC overlay. The outside barriers are 2'-8"± high jersey shape reinforced concrete parapets. The substructure consists of reinforced concrete hammerhead piers and a reinforced concrete stub abutment at the north end of the bridge. The structure shares a pier with BR 1-748 at the south end.

Note, the numbering convention used in this report follows the numbering convention used in the biennial inspection reports where the first span is numbered 1A. This differs from the plans where the first span is numbered 0A.

4.2.2 Location Map



4.2.3 NDE Plan

The bridge deck was surveyed using NDE methods in order to assess the condition of the structural concrete deck and the LMC overlay. The goal of the NDE program was to determine the structural concrete deck's remaining service life and the proposed approximate quantity of structural concrete deck repairs. The assessment was conducted using IE methodology in order to determine the location and severity of observed debonding between the base structural concrete deck and the LMC overlay, and delaminations within the base structural deck. The single lane in the northbound direction was surveyed using IE methodology. A 2' long x 2' wide grid was marked on the bridge deck using water soluble paint and the six (6) spans, or 6 "span-lanes" were tested.

4.2.3.1 NDE Results

The following is a summary of the NDE results. Delaminations are defined as predominately horizontal cracks found in the base structural deck, while debonding is defined as a separation or loss of bond between the base structural deck and the LMC overlay. Results are presented with an IE deck condition rating from 0 to 100 (these are relative condition ratings with respect to each project bridge and cannot be compared to any other bridges) and an overall IE deck condition state of Good, Fair, Poor, or Serious, quantified by deck area percentage (%). Good (or "sound") is defined by the lack of delaminations within the base structural deck. Fair is defined as the potential presence of initial delamination described as occasional (local) separations within the deck. Poor is defined as the presence of a continuous delamination of a smaller width, relative to the depth, or thickness, of the deck. In many cases, it cannot be detected by chain drag or hammer sounding as it is often outside the audible range given the delamination is located deeper within the deck between the top and bottom mats of reinforcing steel. Serious is defined as a continuous delamination of a larger width, relative to the depth and is a result of flexural oscillations of the delaminated part of the deck. It is in the audible range. Areas of the deck in serious condition can be detected by chain drag or hammer sounding given the delamination is located at or near the top mat of reinforcing steel. Note that the IE deck condition states do not correlate with the NBI visual condition state ratings of 7, 5, 4, or 3, respectively. For further information and complete results, please reference the full NDE report in Appendices B and C.

This bridge has an overlay thickness varying between 1.5" and 3". On average, 64% of the deck area shows no signs of delamination. Approximately 22% is in a state of incipient delamination, which can be described as a state where there are signs of a discontinuous delamination (the deck has intermittent cracking, but is mostly connected). 14% of the deck area is in serious condition. For an overlay of this thickness, it is expected that the serious condition represents debonding of the overlay. However, it is possible that the debonding is underlain by delamination. With the exception of Spans 3 and 6, which are in a poor condition, the bridge deck is in fair condition.

4.2.4 Concrete Coring Plan

A total of four (4) 3.25" diameter concrete core samples, 7" to 8" long, were extracted and laboratory tested in accordance with ASTM C42. Compressive strength testing was performed on the structural layers of the deck only, excluding any portion of the LMC overlay in accordance with ASTM C39. Three (3) cores were tested for compressive strength, one (1) of which was additionally tested for water soluble chloride ions in accordance with ASTM C1218. One (1) core was sent to Highbridge Materials Consulting, Inc. for petrographic examination and air-void analysis in accordance with ASTM C856 and ASTM C457, respectively. Three (3) 3" diameter core holes were drilled through the overlay and pull testing was performed in accordance with ASTM C1583.

4.2.4.1 Concrete Core Results

The following is a summary of the concrete coring results; for further information, please reference the full report in Appendix D.

The design strength of the concrete deck is 3000 psi. The tested cores resulted in an average compressive strength of 5370 psi, with a range of 4850 psi to 5950 psi.

Three (3) depth results in the base structural deck (0.5", 1", and 2") were obtained from the water soluble chloride ion core sample. The top layer of steel is located at 1.5" according to the plans. The chloride content is 0.10 lbs./c.y. at the 0.5" depth, 0.00 lbs./c.y. at the 1" depth, and 0.00 lbs./c.y. at the 2" depth. In accordance with DelDOT's Bridge Design Manual May 2005 Figure 9-1, a level of chloride contamination from 0 to 1.3 is considered low, 1.3 to 2.0 is considered moderate, and greater than 2.0 is considered advanced. Therefore chloride contamination in the upper and lower layers is considered low.

Failure of the pull test had a large variability, ranging between 28 psi to 340 psi, with the failure plane noted between the overlay wearing surface and the structural slab bond line. 2 of 3 cores were above the ICRI recommended bond strength of 100 psi.

4.2.4.2 Petrographic Analysis Results

Core 749-1P was sent to Highbridge Materials Consulting, Inc. for petrographic and air voids analysis. The following is a summary of the test results. For further information please reference the "*Petrographic Examination Report*" prepared by Highbridge Materials Consulting, Inc. dated March 22, 2015, in Appendix E.

The petrographic analysis of the cores indicated that the concrete materials were well mixed, cast and consolidated. There were no obvious signs of workmanship deficiencies. The water to cement ratio for the core is estimated to be in the high 0.40's. Core 749-1P had evidence of early stage ASR in the form of axial micro-cracking primarily in the upper 2" of the core. The reactions have not compromised the integrity of the concrete below the upper 2" and no imminent threat is suggested by the existing conditions. However, the ASR reactions could continue to advance if there is a moisture source for this concrete.

The total air voids observed in core 749-1P was 5.8%. Current specifications for concrete exposed to freezing and thawing cycles, per ACI 318 Chapter 4 Section 4, are considered within acceptable limits from 3.5% to 6.5%. The results for this core were found to be in compliance with this specification.

4.2.5 Paint Adhesion Testing

Paint adhesion testing was performed on pre-selected locations throughout the viaduct on representative areas of distressed or peeling paint, in addition to areas where the coating system was intact. A NACE Level 1 certified inspector performed the test utilizing a portable adhesion tester in accordance with ASTM D4541. At each test location, the inspector documented a description of the failure (paint vs. adhesive), and the tensile strength (psi). Additionally, the inspector determined and recorded the coating thickness, utilizing an electronic dry film thickness gauge per the procedures outlined in SSPC-PA2. The variability of the testing results summarized in Appendix F suggests further testing locations are required. After consultation with the Department, it was agreed the entire superstructure will be repainted.

4.2.6 Summary of Findings

The following is a summary of the visual inspection findings; for further information, please reference the inspection field observation notes in Appendix H.

The concrete deck exhibits random hairline cracking and isolated delaminations and spalls with exposed corroded steel reinforcement in the soffit (see Photo 1). Spans 5 and 6 exhibit a large bituminous patched area (see Photo 2). The deck joints exhibit debonded, depressed or torn material, are filled with debris, and the steel armoring exhibits surface corrosion and scrapes. 2 of 6 scuppers are 100% clogged with debris and not functional. The beams and girders exhibit random areas of freckled corrosion; the ends exhibit minor to severe corrosion, predominately to the top and bottom flange edges (see Photo 3). The webs and bearing stiffeners exhibit up to 1/4" painted over pitting. Steel diaphragms exhibit minor to severe corrosion at the piers, and random areas of peeling paint with exposed primer to the bottom flanges throughout. The bearings exhibit minor corrosion to the plate edges, 1/8" rust delaminations, 1/8"

pack rust between plates, and up to 1/4" pack rust between masonry plates and pedestals (see Photo 4). The concrete abutment and piers exhibit cracks with corrosion stains, delaminations, and spalls with exposed corroded steel reinforcement (see Photos 5 and 6).

4.2.6.1 Defect Photographs

The defect photos are representative of the as-inspected condition; additional photos are available upon request.



Photo 1: Soffit delamination with efflorescence (Span 4, Bay 3)

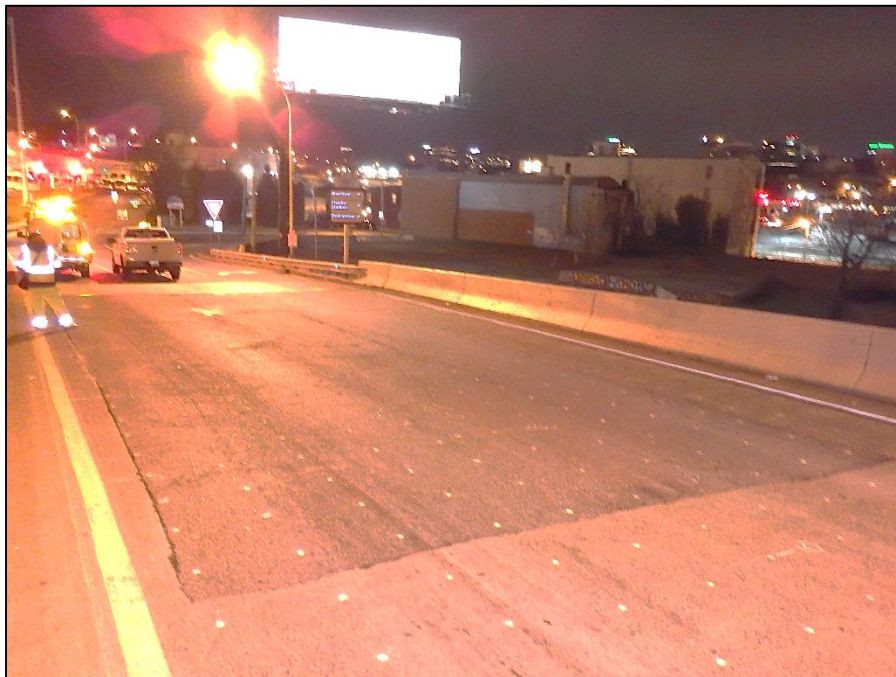


Photo 2: Large bituminous patch (Spans 5 & 6)



Photo 3: Corrosion and pitting at ends of girders (Spans 2 & 3, Girder 1)



Photo 4: Corroded and fully contracted bearing (Span 2, Bearing 1 at Pier 2)



Photo 5: Delamination with associated 2'-6" high x 1/4" wide vertical crack (Pier 1, Southwest Corner)



Photo 6: Delamination and spall with exposed corroded steel reinforcement (Pier 2, North Face)



Photo 7: Disconnected and clogged downspout (Pier 3, South Face)

4.2.7 Defect Tables

BR 1-749 Deck Defects – Deck to be replaced.

BR 1-749 Superstructure Defects

Defect Number	Location	Description
S-2-1	Bearings 1 to 4, Pier 2, Span 2	Bearings are in full contraction at 40° F.
S-4-1	Bearing 4, Pier 4, Span 4	West anchor bolt nut is backed off and frozen to top thread.
S-5-1	Bearing 1, Pier 4, Span 5	West anchor bolt nut is backed off and frozen to top thread.

BR 1-749 Substructure Defects

Defect Number	Location	Description
P-1-1	Pier 1, Underside, East Overhang	6" wide x 8" long x 1/2" deep spall with exposed reinforcement.
P-1-2	Pier 1, Underside, East Overhang	6" wide x 8" long x 1/2" deep spall with exposed reinforcement.
P-1-3	Pier 1, Underside, East Overhang	6" wide x 8" long x 1/2" deep spall with exposed reinforcement.
P-1-4	Pier 1, Underside, East Overhang	6" wide x 8" long x 1/2" deep spall with exposed reinforcement.
P-1-5	Pier 1, South Face	3'-0" high x 1/16" wide vertical crack with corrosion.
P-1-6	Pier 1, South Face	1'-1" wide x 1'-9" high area of delaminated concrete.
P-1-7	Pier 1, South Face, West Overhang	1'-1" wide x 1'-4" high x 1" deep spall.
P-1-8	Pier 1, Southwest Corner	1'-2" wide x 2'-0" high area of delaminated concrete with a 2'-6" long x 1/4" wide crack.
P-1-9	Pier 1, South Face	4'-0" long x 1/16" wide vertical crack with corrosion.
P-2-1	Pier 2, North Face	1'-1" wide x 1'-3" high area of delaminated concrete.
P-2-2	Pier 2, Underside, West Overhang	1'-4" wide x 2'-7" long x 3" deep spall at north corner.
P-2-3	Pier 2, South Face	10" wide x 2'-3" high x 1" deep spall.
P-2-4	Pier 2, South Face	3'-2" wide x 4'-5" high area of delaminated concrete with a 3'-0" long x 1/16" wide vertical crack with corrosion.
P-2-5	Pier 2, West Face of Pedestal 3	9" wide x 5" high x 3/4" deep spall.
P-2-6	Pier 2, West Face	4'-0" long x 1/16" wide vertical crack with corrosion.

BR 1-749 Substructure Defects (Continued)

Defect Number	Location	Description
P-2-7	Pier 2, Top Face, Bay 1	1'-6" wide x 1'-6" long x 1-1/2" deep spall.
P-2-8	Pier 2, Top Face, Bay 1	2'-3" long x 1/16" wide crack.
P-3-1	Pier 3, North Face, East Overhang	7" wide x 9" high area of delaminated concrete.
P-3-2	Pier 3, North Face, East Overhang	10" wide x 2'-4" high x 3/4" deep spall with exposed steel reinforcement.
P-3-3	Pier 3, North Face, East Overhang	9" wide x 1'-10" high x 3/4" deep spall with exposed steel reinforcement.
P-3-4	Pier 3, North Face, East Overhang	8" wide x 1'-10" high x 3/4" deep spall with exposed steel reinforcement.
P-3-5	Pier 3, North Face, East Overhang	4-1/2" wide x 8" high area of delaminated concrete.
P-3-6	Pier 3, North Face, East Overhang	1'-2" wide x 2'-4" high x 2/4" deep spall with exposed steel reinforcement.
P-3-7	Pier 3, Northeast Corner	3'-8" wide x 3'-1" high area of delaminated concrete.
P-3-8	Pier 3, East Face	1'-0" wide x 6" high area of delaminated concrete.
P-3-9	Pier 3, South Face of Pedestal 2	5" wide x 4" high x 1/2" deep spall.
P-3-10	Pier 3, Underside, East Overhang	4" wide x 7" long area of delaminated concrete.
P-3-11	Pier 3, South Face	Clogged downspout with 3'-0" length of pipe missing near the bottom.
P-4-1	Pier 4, Top Face, North Corner	1'-0" wide x 1'-6" long area of delaminated concrete with a 3'-6" long x 1/16" wide crack.
P-4-2	Pier 4, West Face of Pedestal 3	1'-2' wide x 3'-0" long x 8" high corner spall.
P-4-3	Pier 4, South Face	Clogged downspout with 3'-0" length of pipe missing near the bottom.
P-5-1	Pier 5, North Face, East Overhang	8'-0" long x 1/16" wide crack.
P-5-2	Pier 5, North Face	3'-2" wide x 1'-0" high area of delaminated concrete.
P-5-3	Pier 5, Northeast Corner	8" wide x 1'-1" high x 1/2" deep spall.
P-5-4	Pier 5, Northwest Corner of Pedestal 3	1'-4" wide x 8" high area of delaminated concrete.
P-5-5	Pier 5, Northwest Corner of Pedestal 4	2'-9" wide x 7" high x 4" deep corner spall.
P-5-6	Pier 5, South Face, East Overhang	6'-0" long x 1/16" wide crack.

BR 1-749 Substructure Defects (Continued)

Defect Number	Location	Description
P-5-7	Pier 5, Underside, East Overhang	5" wide x 1'-5" long area of delaminated concrete.
P-5-8	Pier 5, Underside, East Overhang	8" wide x 1'-0" long area of delaminated concrete.
P-5-9	Pier 5, Top Face, West Overhang	1'-8" diameter area of delaminated concrete.
P-5-10	Pier 5, Top Face, East Overhang	4'-0" long x 1/16" wide vertical crack.
P-5-11	Pier 5, South Face	Clogged downspout with 3'-0" length of pipe missing near the bottom.
A-6-1	North Abutment, East Wingwall	7" wide x 14" long x 1-1/2" deep spall.
A-6-2	North Abutment, West Wingwall	3" wide x 2'-8" high x 1/4" deep spall with exposed rebar.
A-6-3	North Abutment, West Wingwall	3'-0" wide x 1'-3" high x 3-1/2" deep spall with exposed and corroded steel reinforcement.

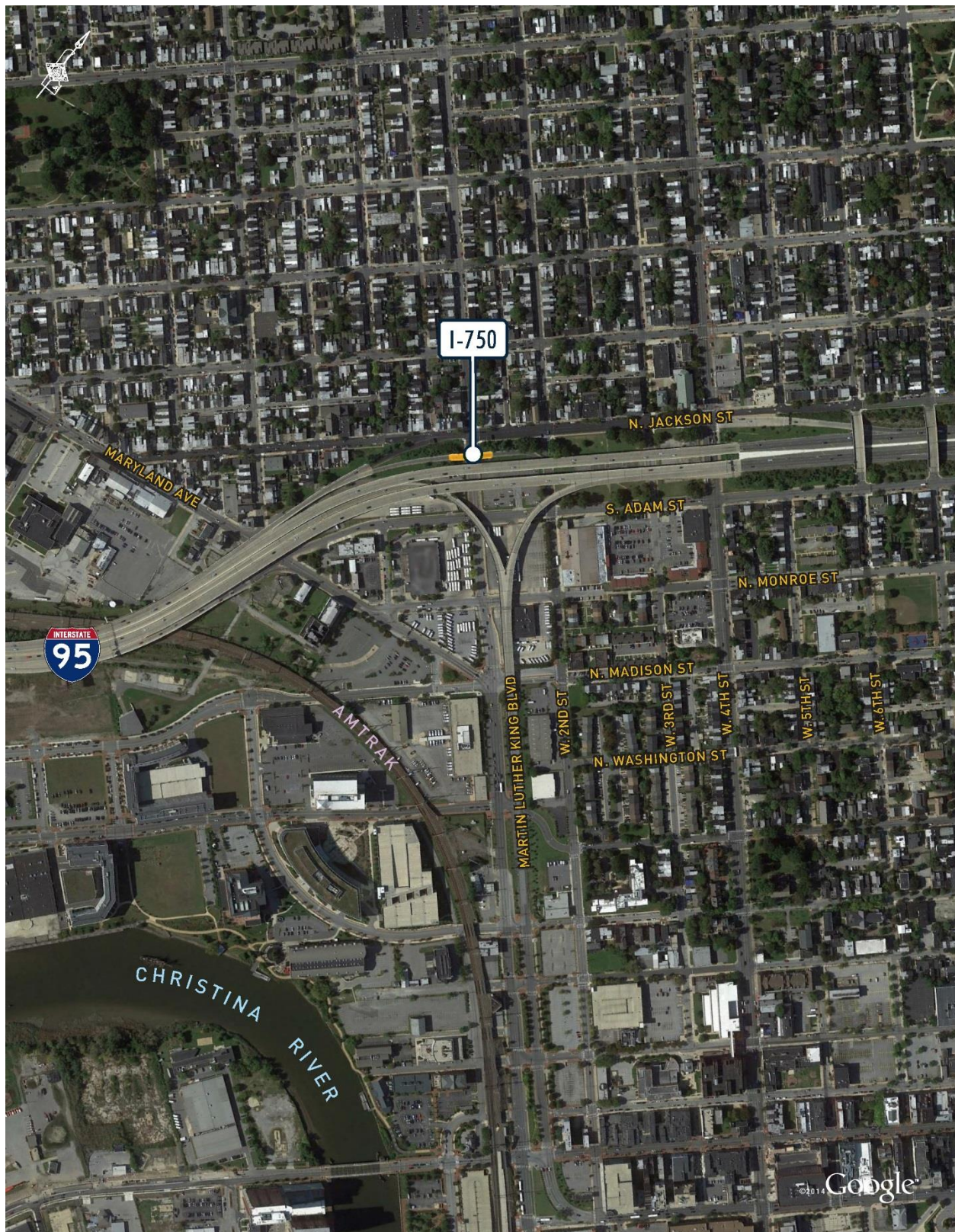
4.3 Bridge 1-750

4.3.1 Bridge Description

Bridge 1-750 (Ramp C) is a ramp from SR48 to I-95 SB over Lancaster Ave. (see Location Map in Section 4.3.2). The structure is a three (3) span simply supported steel beam bridge built in 1964. The bridge has an overall length of 146'-0"± with span lengths of 28'-0"±, 78'-0"±, and 40'-0"±. The bridge has an out-to-out width of 27'-2"± providing a clear roadway width of 22'-0"±. The bridge carries one (1) lane of traffic from SR 48 to BR 1-758. The superstructure in Spans 1 - 3 consists of four (4) painted steel rolled beams with welded cover plates supporting a 7½"± thick reinforced concrete deck. According to plans, the existing deck is protected by a 2¼" thick LMC overlay. The outside barriers are 2'-8"± high jersey shape reinforced concrete parapets. The substructure consists of reinforced concrete hammerhead piers and reinforced concrete stub abutments.

Note, the numbering convention used in this report follows the numbering convention used in the biennial inspection reports where the spans are numbered from the south and the first span is numbered 1. This differs from the plans where the spans are numbered from the north and the first span is numbered 0C.

4.3.2 Location Map



4.3.3 NDE Plan

The bridge deck was surveyed using NDE methods in order to assess the condition of the structural concrete deck and the LMC overlay. The goal of the NDE program was to determine the structural concrete deck's remaining service life and the proposed approximate quantity of structural concrete deck repairs. The assessment was conducted using impact echo (IE) methodology in order to determine the location and severity of observed debonding between the base structural concrete deck and the LMC overlay, and delaminations within the base structural deck. The single lane in the southbound direction was surveyed using IE methodology. A 2' long x 2' wide grid was marked on the bridge deck using water soluble paint and the three (3) spans, or 3 "span-lanes" were tested.

4.3.3.1 NDE Results

The following is a summary of the NDE results. Delaminations are defined as predominately horizontal cracks found in the base structural deck, while debonding is defined as a separation or loss of bond between the base structural deck and the LMC overlay. Results are presented with an IE deck condition rating from 0 to 100 (these are relative condition ratings with respect to each project bridge and cannot be compared to any other bridges) and an overall IE deck condition state of Good, Fair, Poor, or Serious, quantified by deck area percentage (%). Good (or "sound") is defined by the lack of delaminations within the base structural deck. Fair is defined as the potential presence of initial delamination described as occasional (local) separations within the deck. Poor is defined as the presence of a continuous delamination of a smaller width, relative to the depth, or thickness, of the deck. In many cases, it cannot be detected by chain drag or hammer sounding as it is often outside the audible range given the delamination is located deeper within the deck between the top and bottom mats of reinforcing steel. Serious is defined as a continuous delamination of a larger width, relative to the depth and is a result of flexural oscillations of the delaminated part of the deck. It is in the audible range. Areas of the deck in serious condition can be detected by chain drag or hammer sounding given the delamination is located at or near the top mat of reinforcing steel. Note that the IE deck condition states do not correlate with the NBI visual condition state ratings of 7, 5, 4, or 3, respectively. For further information and complete results, please reference the full NDE report in Appendices B and C.

This bridge has an overlay thickness varying between 1.75" and 3". On average, 45% of the deck area shows no signs of delamination. Approximately 33% is in a state of incipient delamination, which can be described as a state where there are signs of a discontinuous delamination (the deck has intermittent cracking, but is mostly connected). 21% of the deck area is in serious condition. For an overlay of this thickness, it is expected that the serious condition represents debonding of the overlay. However, it is possible that the debonding is underlain by delamination. The majority of debonding / delaminations are along the bridge joints. Overall, the bridge deck is in poor condition.

4.3.4 Concrete Coring Plan

A total of four (4) 3.25" diameter concrete core samples, 6.5" to 7.5" long, were extracted and laboratory tested in accordance with ASTM C42. Compressive strength testing was performed on the structural layers of the deck only, excluding any portion of the LMC overlay in accordance with ASTM C39. Three (3) cores were tested for compressive strength, one (1) of which was additionally tested for water soluble chloride ions in accordance with ASTM C1218. One (1) core was sent to Highbridge Materials Consulting, Inc. for petrographic examination and air-void analysis in accordance with ASTM C856 and ASTM C457, respectively.

4.3.4.1 Concrete Core Results

The following is a summary of the concrete coring results; for further information, please reference the full report in Appendix D.

The design strength of the concrete deck is 3000 psi. The tested cores resulted in an average compressive strength of 5820 psi, with a range of 5550 psi to 6260 psi.

Three (3) depth results in the base structural deck (0.5", 1", and 2") were obtained from the water soluble chloride ion core sample. The top layer of steel is located at 1" according to the plans. The chloride content is 0.05 lbs./c.y. at the 0.5" depth, 0.00 lbs./c.y. at the 1" depth, and 0.00 lbs./c.y. at the 2" depth. In accordance with DelDOT's Bridge Design Manual May 2005 Figure 9-1, a level of chloride contamination from 0 to 1.3 is considered low, 1.3 to 2.0 is considered moderate, and greater than 2.0 is considered advanced. Therefore chloride contamination in the upper and lower layers is considered low.

4.3.4.2 Petrographic Analysis Results

Core 750-1P was sent to Highbridge Materials Consulting, Inc. for petrographic and air voids analysis. The following is a summary of the test results. For further information please reference the "*Petrographic Examination Report*" prepared by Highbridge Materials Consulting, Inc. dated March 22, 2015, in Appendix E.

The petrographic analysis of the cores indicated that the concrete materials were well mixed, cast and consolidated. There were no obvious signs of workmanship deficiencies. The water to cement ratio for the core is estimated to be in the mid to high 0.40's. Core 750-1P had trace levels of incipient scaling within the uppermost millimeter of the core. This scaling may have been the result from the scarification process used prior to the application of the overlay. There was no evidence of ASR present in the core sample.

The total air voids observed in core 750-1P was 8.5%. This value exceeds modern specifications for concrete that is exposed to freezing and thawing. Current specifications for concrete exposed to freezing and thawing cycles is 3.5% to 6.5% per ACI 318 Chapter 4 Section 4. Concrete with high air content may have lower compressive strengths. The compressive strength data for the cores extracted from this structure did not indicate a reduction in strength due to this higher air content.

4.3.5 Paint Adhesion Testing

Paint adhesion testing was performed on pre-selected locations throughout the viaduct on representative areas of distressed or peeling paint, in addition to areas where the coating system was intact. A NACE Level 1 certified inspector performed the test utilizing a portable adhesion tester in accordance with ASTM D4541. At each test location, the inspector documented a description of the failure (paint vs. adhesive), and the tensile strength (psi). Additionally, the inspector determined and recorded the coating thickness, utilizing an electronic dry film thickness gauge per the procedures outlined in SSPC-PA2. The variability of the testing results summarized in Appendix F suggests further testing locations are required. After consultation with the Department, it was agreed the entire superstructure will be repainted.

4.3.6 Summary of Findings

The following is a summary of the visual inspection findings; for further information, please reference the inspection field observation notes in Appendix H.

The concrete deck exhibits isolated shallow soffit spalls. The LMC overlay exhibits moderate wear. The deck joints are filled with debris. The drainage basin is clear and functional. The beams exhibit random areas of freckled corrosion; the ends exhibit minor corrosion, predominately to the top flange edges. Diaphragms exhibit minor corrosion at the piers. The bearings exhibit minor corrosion to the plate edges, 1/8" rust delaminations, 1/8" pack rust between plates (see Photo 1), and up to 1/4" pack rust between masonry plates and pedestals. The concrete abutment and piers exhibit cracks with corrosion stains, delaminations, and spalls with exposed corroded steel reinforcement (see Photo 2).

4.3.6.1 Defect Photographs

The defect photos are representative of the as-inspected condition; additional photos are available upon request.



Photo 1: Pack rust between plates (Bearing 1, Span 1 at Pier 1)



Photo 2: Spall with exposed corroded steel reinforcement (Span 2, Pier 2)

4.3.7 Defect Tables

BR 1-750 Deck Defects – Deck to be replaced.

BR 1-750 Superstructure Defects

Defect Number	Location	Description
S-1-1	Bearing 1, Pier 1, Span 1	1/4" pack rust between masonry plate and shim plate at front face that could prevent contraction.
S-1-2	Bearing 4, Pier 1, Span 1	1/4" pack rust between sole plate and masonry plate preventing rotation.

BR 1-750 Substructure Defects

Defect Number	Location	Description
A-1-1	South Abutment Slope Protection, west side at stem	6'-0" diameter x 6" deep area of settlement.
P-1-1	Pier 1, North Face below Bay 1, East Overhang	3'-0" long x 1/16" wide horizontal crack.
P-1-2	Pier 1, East Face of Pedestal 1	2" wide x 2'-6" high x 1/2" deep spall with exposed steel reinforcement.
P-1-3	Pier 1, South Face between Beams 2 and 3	2'-5" wide x 4'-2" high area of delaminated concrete.
P-1-4	Pier 1, South Face between Beams 2 and 3	4'-0" long x 1/4" wide crack around abandoned conduit
P-1-5	Pier 1, West Face of Pedestal 4	5" wide x 1'-2" high x 2" deep spall with exposed steel reinforcement.
P-1-6	Pier 1, South Face between Beams 2 and 3	Abandoned conduit.
P-2-1	Pier 2, North Face below Bay 1, East Overhang	2'-0" wide x 2'-10" high x 1 3/4" deep spall with exposed steel reinforcement.
P-2-2	Pier 2, North Face below Bay 1, East Overhang	2'-2" wide x 3'-0" high area of delaminated concrete that continues onto the underside of the overhang.
P-2-3	Pier 2, North Face, Bay 2	2'-11" wide x 3'-10" high area of delaminated concrete.
P-2-4	Pier 2, South Face, Bay 2	1'-2" wide x 1'-9" high area of delaminated concrete.
P-2-5	Pier 2, South Face of Pedestal 2	7" wide x 11" high area of delaminated concrete.
P-2-6	Pier 2, South Face of Pedestal 4	6" wide x 1'-0" high area of delaminated concrete.

BR 1-750 Substructure Defects (Continued)

Defect Number	Location	Description
P-2-7	Pier 2, South Face of Pedestal 4	6" wide x 1'-6" high x 5" deep spall continuing onto the west face.
P-2-8	Pier 2, West Face of Pedestal 4	9" wide x 3'-3" high area of delaminated concrete.
P-2-9	Pier 2, below Beam 4, Underside of East Overhang	1'-6" wide x 1'-6" high are of delaminated concrete.
A-3-1	North Abutment Slope Protection	Cracking and vegetation growth throughout slope protection.
A-3-2	North Abutment Slope Protection	Evidence of leakage and a 4" depression in slope protection.

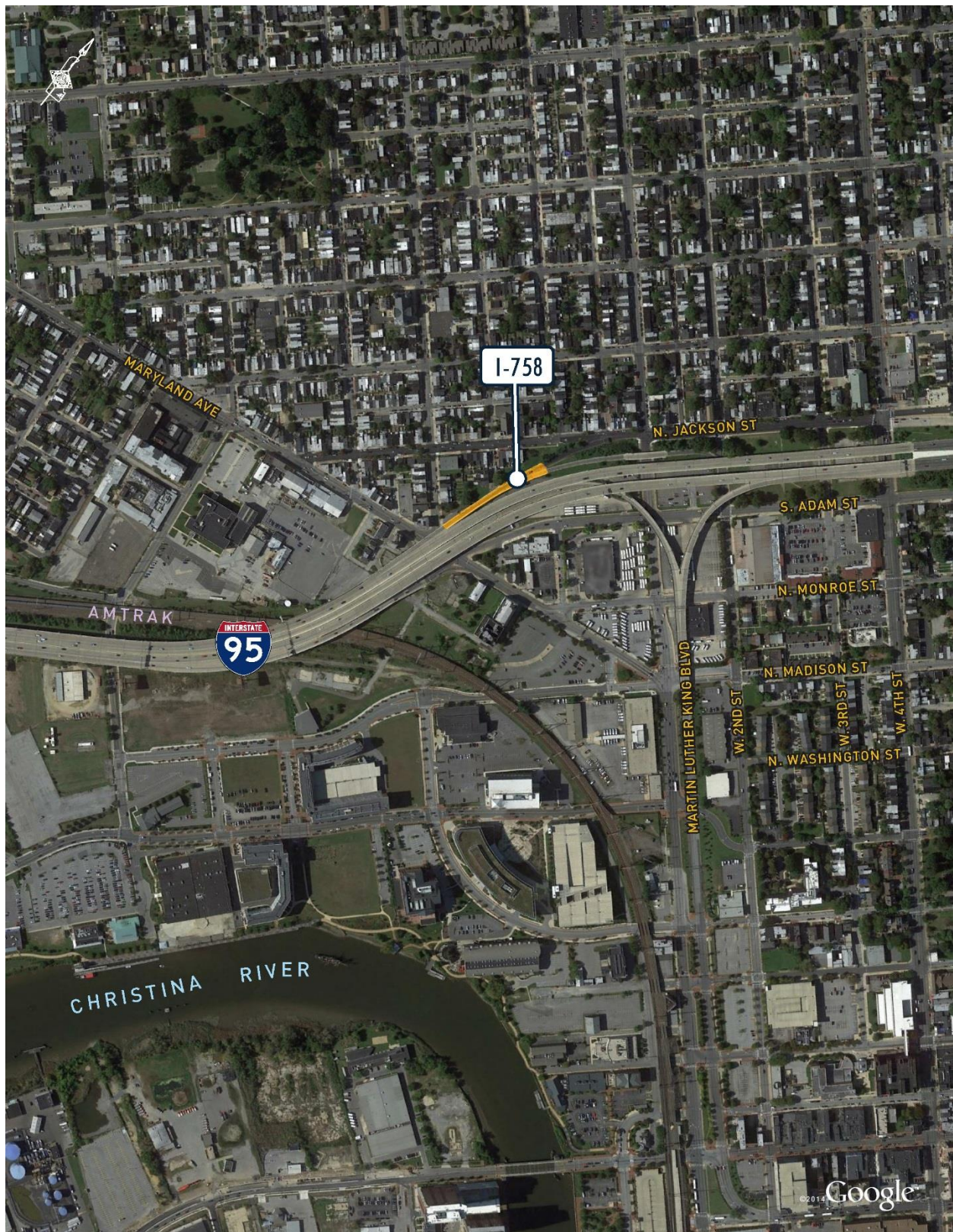
4.4 Bridge 1-758

4.4.1 Bridge Description

Bridge 1-758 (Ramp B) is a ramp from SR48 to I-95 SB over Maryland Ave. and Linden St. (see Location Map in Section 4.4.2). The structure is a seven (7) span simply supported steel beam bridge built in 1964. The bridge has an overall length of 461'-11"± with span lengths of 50'-0"±, 60'-0"±, 60'-0"±, 85'-0"±, 73'-0"±, 70'-0"±, and 63'-11"±. The bridge has an out-to-out width that varies from 23'-2"± to 48'-4 13/16"± providing a clear roadway width that varies from 18'-0"± to 43'-2 13/16"±. At the north end, the bridge carries two (2) lanes of traffic, one (1) from SR 48 and one (1) from BR 1-750. On the bridge, the two (2) lanes of traffic merge, and the bridge carries one (1) lane of traffic onto I-95 SB (BR1-748). Span 1 consists of seven (7) painted steel rolled beams with welded cover plates. Span 2 consists of six (6) painted steel rolled beams with welded cover plates. Span 3 consists of five (5) painted steel rolled beams with welded cover plates. Spans 4 – 7 consist of four (4) painted steel rolled beams with covers plates. Spans 1 – 3 and 5 – 7 support a 7½"± thick reinforced concrete deck. Span 4 supports an 8"± thick reinforced concrete deck. According to plans, the existing deck is protected by a 2¼" thick LMC overlay. The outside barriers are 2'-8"± high jersey shape reinforced concrete parapets. The substructure consists of reinforced concrete hammerhead piers and a reinforced concrete stub abutment at the north end of the bridge. The structure shares a pier with BR 1-748 at the south end.

Note, the numbering convention used in this report follows the numbering convention used in the biennial inspection reports where the first span is numbered 1. This differs from the plans where the first span is numbered 0B.

4.4.2 Location Map



4.4.3 NDE Plan

The bridge deck was surveyed using NDE methods in order to assess the condition of the structural concrete deck and the LMC overlay. The goal of the NDE program was to determine the structural concrete deck's remaining service life and the proposed approximate quantity of structural concrete deck repairs. The assessment was conducted using IE methodology in order to determine the location and severity of observed debonding between the base structural concrete deck and the LMC overlay, and delaminations within the base structural deck. The left and right lanes in Spans 1 and 2, and the single lane in Spans 3 through 7 in the southbound direction were surveyed using IE methodology. A 2' long x 2' wide grid was marked on the bridge deck using water soluble paint and the seven (7) spans, or 9 "span-lanes" were tested.

4.4.3.1 NDE Results

The following is a summary of the NDE results. Delaminations are defined as predominately horizontal cracks found in the base structural deck, while debonding is defined as a separation or loss of bond between the base structural deck and the LMC overlay. Results are presented with an IE deck condition rating from 0 to 100 (these are relative condition ratings with respect to each project bridge and cannot be compared to any other bridges) and an overall IE deck condition state of Good, Fair, Poor, or Serious, quantified by deck area percentage (%). Good (or "sound") is defined by the lack of delaminations within the base structural deck. Fair is defined as the potential presence of initial delamination described as occasional (local) separations within the deck. Poor is defined as the presence of a continuous delamination of a smaller width, relative to the depth, or thickness, of the deck. In many cases, it cannot be detected by chain drag or hammer sounding as it is often outside the audible range given the delamination is located deeper within the deck between the top and bottom mats of reinforcing steel. Serious is defined as a continuous delamination of a larger width, relative to the depth and is a result of flexural oscillations of the delaminated part of the deck. It is in the audible range. Areas of the deck in serious condition can be detected by chain drag or hammer sounding given the delamination is located at or near the top mat of reinforcing steel. Note that the IE deck condition states do not correlate with the NBI visual condition state ratings of 7, 5, 4, or 3, respectively. For further information and complete results, please reference the full NDE report in Appendices B and C.

This bridge has an overlay thickness varying between 2" and 3". On average, 42% of the deck area shows no signs of delamination. Approximately 43% is in a state of incipient delamination, which can be described as a state where there are signs of a discontinuous delamination (the deck has intermittent cracking, but is mostly connected). 16% of the deck area is in serious condition. For an overlay of this thickness, it is expected that the serious condition represents debonding of the overlay. However, it is possible that the debonding is underlain by delamination. The bridge deck is in fair to poor condition, while Spans 1, 2 and 7 are in poor to serious condition. Delaminations are randomly distributed throughout the structural deck.

4.4.4 Concrete Coring Plan

A total of four (4) 3.25" diameter concrete core samples, 6" to 9" long, were extracted and laboratory tested in accordance with ASTM C42. Compressive strength testing was performed on the structural layers of the deck only, excluding any portion of the LMC overlay in accordance with ASTM C39. Three (3) cores were tested for compressive strength, one (1) of which was additionally tested for water soluble chloride ions in accordance with ASTM C1218. One (1) core was sent to Highbridge Materials Consulting, Inc. for petrographic examination and air-void analysis in accordance with ASTM C856 and ASTM C457, respectively.

4.4.4.1 Concrete Core Results

The following is a summary of the concrete coring results; for further information, please reference the full report in Appendix D.

The design strength of the concrete deck is 3000 psi. The tested cores resulted in an average compressive strength of 6360 psi, with a range of 5930 psi to 6750 psi.

Three (3) depth results in the base structural deck (0.5", 1", and 2") were obtained from the water soluble chloride ion core sample. The top layer of steel is located at 1.5" according to the plans. The chloride content is 0.04 lbs./c.y. at the 0.5" depth, 0.00 lbs./c.y. at the 1" depth, and 0.00 lbs./c.y. at the 2" depth. In accordance with DelDOT's Bridge Design Manual May 2005 Figure 9-1, a level of chloride contamination from 0 to 1.3 is considered low, 1.3 to 2.0 is considered moderate, and greater than 2.0 is considered advanced. Therefore chloride contamination in the upper and lower layers is considered low.

4.4.4.2 Petrographic Analysis Results

Core 758-1P was sent to Highbridge Materials Consulting, Inc. for petrographic and air voids analysis. The following is a summary of the test results. For further information please reference the "*Petrographic Examination Report*" prepared by Highbridge Materials Consulting, Inc. dated March 22, 2015, in Appendix E.

The petrographic analysis of the cores indicated that the concrete materials were well mixed, cast and consolidated. There were no obvious signs of workmanship deficiencies. The water to cement ratio for the core is estimated to be in the mid to high 0.40's. Core 758-1P had a trace amount of ASR present in the very top of the core just beneath the overlay interface and within a fractured silty ironstone aggregate particle in the bottom of the core. Other than these two indications, there was no other evidence of ASR present in this core.

The total air voids observed in core 758-1P was 9.0%. This value exceeds modern specifications for concrete that is exposed to freezing and thawing. Current specifications for concrete exposed to freezing and thawing cycles is 3.5% to 6.5% per ACI 318 Chapter 4 Section 4. Concrete with high air content may have lower compressive strengths. The compressive strength data for the cores extracted from this structure did not indicate a reduction in strength due to this higher air content.

4.4.5 Paint Adhesion Testing

Paint adhesion testing was performed on pre-selected locations throughout the viaduct on representative areas of distressed or peeling paint, in addition to areas where the coating system was intact. A NACE Level 1 certified inspector performed the test utilizing a portable adhesion tester in accordance with ASTM D4541. At each test location, the inspector documented a description of the failure (paint vs. adhesive), and the tensile strength (psi). Additionally, the inspector determined and recorded the coating thickness, utilizing an electronic dry film thickness gauge per the procedures outlined in SSPC-PA2. The variability of the testing results summarized in Appendix F suggests further testing locations are required. After consultation with the Department, it was agreed the entire superstructure will be repainted.

4.4.6 Summary of Findings

The following is a summary of the visual inspection findings; for further information, please reference the inspection field observation notes in Appendix H.

The LMC overlay has no visible defects affecting the structural deck below. The deck joints exhibit debonded, depressed or torn material, are filled with debris, and the steel armoring exhibits surface corrosion and scrapes. 2 of 3 scuppers are 100% clogged with debris and not functioning. The beams exhibit random areas of freckled corrosion; the ends exhibit minor to severe corrosion, predominately to the top flange edges. The webs and bearing stiffeners exhibit up to 1/8" painted over pitting. Steel diaphragms exhibit minor to severe corrosion at the piers, and random areas of freckled corrosion throughout. The bearings are mostly covered in grease; those that are not greased exhibit minor corrosion to the plate edges, 1/8" rust delaminations, 1/8" pack rust between plates, and up to 1/4" pack rust between masonry plates and pedestals (see Photos 2 and 3). Previous seismic retrofits have put anchor bolt nuts in contact with keeper plates, having the potential to restrict proper movement. The concrete abutment and piers exhibit cracks with corrosion stains, delaminations, and spalls with exposed corroded steel reinforcement (see Photos 4 and 5).

4.4.6.1 Defect Photographs

The defect photos are representative of the as-inspected condition; additional photos are available upon request.



Photo 1: Soffit delamination (Span 2, Bay 2)



Photo 2: Typical corrosion, rust delaminations, pack rust (Span 3, Bearing 1 at Pier 3)



Photo 3: Pack rust preventing movement (Span 6, Bearing 4)



Photo 4: Typical spall with exposed corroded steel reinforcement (Pier 4, Pedestal 2)



Photo 5: Typical crack and area of delaminated concrete in top of pier cap (Pier 4, Bay 3)

4.4.7 Defect Tables

BR 1-758 Deck Defects – Deck to be replaced.

BR 1-758 Superstructure Defects

Defect Number	Location	Description
S-2-1	Span 2, Pier 3, Bearing 4	East anchor bolt nut is cross threaded and backed off.
S-3-1	Span 3, Pier 3, Bearing 1	Severe corrosion; Bearing appears to be frozen with no signs of movement.
S-5-1	Span 5, Pier 5 Bearings	Contracted flush with masonry plate at 40 degrees Fahrenheit.
S-6-1	Span 6, Pier 6, Bearing 4	1/4" pack rust between sole and sliding plates. 1/4" pack rust between masonry and shim plates on front face may prevent contraction.
S-6-2	Span 6, Pier 6 Bearings	Contracted flush with masonry plate at 40 degrees Fahrenheit.

BR 1-758 Substructure Defects

Defect Number	Location	Description
A-1-1	North Abutment, West Face of Pedestal 1	1'-1" wide x 2'-3" long area of delaminated concrete.
A-1-2	North Abutment, East Face of Pedestal 2	1'-0" wide x 2'-6" long area of delaminated concrete that extends to south face.
A-1-3	North Abutment, South Face of Pedestal 3	4'-4" wide x 3'-0" long area of delaminated concrete that extends to top of the pedestal.
A-1-4	North Abutment, West Face of Pedestal 5	1'-0" wide x 1'-0" long area of delaminated concrete.
A-1-5	North Abutment Backwall, Bay 2	3'-6" wide x 9" high area of delaminated concrete.
A-1-6	North Abutment Backwall, Bay 2	10" wide x 7" high area of delaminated concrete.
A-1-7	North Abutment Backwall, Bay 3	4'-0" wide x 9" high area of delaminated concrete.
A-1-8	North Abutment Backwall, Bay 3	5'-0" long x 1/8" wide horizontal crack.
A-1-9	North Abutment Seat	Excessive debris throughout from vagrants living under Span 1.
P-1-1	Pier 1, North Face of Pedestal 2	1'-10" wide x 1'-9" high area of delaminated concrete.
P-1-2	Pier 1, North Face below Beam 2	2'-7" wide x 6" high area of delaminated concrete.
P-1-3	Pier 1, North Face below Beam 3	2'-9" wide x 6" high area of delaminated concrete.

BR 1-758 Substructure Defects

Defect Number	Location	Description
P-3-1	Pier 3, North Face of Pedestal 1	1'-4" wide x 6" high area of delaminated concrete.
P-3-2	Pier 3, South Face of Pedestal 1	3'-2" long x 1'-3" high delaminated patch.
P-3-3	Pier 3, West Face of Pedestal 1	2'-10" wide x 6" high area of delaminated concrete.
P-3-4	Pier 3, South Face below Bay 1, East Overhang	2'-6" long x 1/16" wide horizontal crack.
P-3-5	Pier 3, South Face below Bay 1, East Overhang	Downspout is clogged with debris.
P-3-6	Pier 3, East Face of Pedestal 2	1'-10" long x 6" high area of delaminated concrete.
P-3-7	Pier 3, South Face of Pedestal 2	7" wide x 1'-0" high area of delaminated concrete.
P-3-8	Pier 3, South Face below Bay 2	2'-9" wide x 1'-5" high area of delaminated concrete.
P-3-9	Pier 3, South Face below Bay 3, West Overhang	2'-2" long x 1/16" wide horizontal crack.
P-4-1	Pier 4, North Face of Pedestal 1	2'-0" wide x 4 1/2" high corner delamination extending 4" onto top of pedestal.
P-4-2	Pier 4, South Face of Pedestal 1	2'-6" wide x 4 1/2" high x 5" deep corner spall with exposed corroded steel reinforcement.
P-4-3	Pier 4, South Face below Pedestal 1, East Overhang	1'-10" wide x 9" high delaminated patch.
P-4-4	Pier 4, North Face below Bay 1, East Overhang	4'-6" wide x 9" high delaminated patch.
P-4-5	Pier 4, Top Face between Pedestals 1 and 2	3'-0" long x 1/8" wide crack at north end.
P-4-6	Pier 4, Top Face between Pedestals 1 and 2	3'-0" long x 1/8" wide crack at south end.
P-4-7	Pier 4, South Face below Bay 1, East Overhang	1'-2" wide x 5" high delaminated patch.
P-4-8	Pier 4, North Face of Pedestal 2	3'-4" wide x 7" high x 4" deep spall with exposed corroded steel reinforcement.
P-4-9	Pier 4, West Face of Pedestal 2	2'-0" wide x 7" high area of delaminated concrete with 1" deep spalling at the north edge.
P-4-10	Pier 4, South Face below Pedestal 3, West Overhang	2'-0" wide x 8" high delaminated patch.
P-4-11	Pier 4, North Face below Bay 3, West Overhang	2'-0" wide x 1'-2" high delaminated patch.
P-4-12	Pier 4, Top Face between Pedestals 3 and 4	3'-0" long x 1/8" wide crack at north end.
P-4-13	Pier 4, Top Face between Pedestals 3 and 4	3'-0" long x 1/4" wide crack at south end.

BR 1-758 Substructure Defects

Defect Number	Location	Description
P-5-1	Pier 5, South Face of Pedestal 2	6" wide x 3" high corner delamination extending 5" wide into West Face.
P-5-2	Pier 5, South Face below Bay 2	3'-0" high x 1/16" wide crack with corrosion stains.
P-5-3	Pier 5, North Face of Pedestal 4	1'-6" wide x 4" high area of delaminated concrete with 1'-8" long x 1/16" wide perimeter crack.
P-6-1	Pier 6, West Face of Pedestal 1	2'-9" wide x 10" high area of delaminated concrete with 1/16" wide perimeter cracking.
P-6-2	Pier 6, East Face of Pedestal 2	1'-4" wide x 7" high area of delaminated concrete.
P-6-3	Pier 6, South Face of Pedestal 2	5" wide x 7" high area of delaminated concrete.
P-6-4	Pier 6, East Face of Pedestal 3	1'-2" wide x 4" high area of delaminated concrete with associated 3'-5" long x 1/16" wide horizontal cracks.
P-6-5	Pier 6, West Face of Pedestal 3	2'-0" wide x 11" high area of delaminated concrete.
P-6-6	Pier 6, North Face of Pedestal 4	1'-0" wide x 4" high area of delaminated concrete with associated 1'-0" wide x 1/8" wide horizontal crack.
P-6-7	Pier 6, South Face of Pedestal 4	2'-6" wide x 11" high area of delaminated concrete.
P-6-8	Pier 6, South Face below Pedestal 4	1'-1" wide x 11" high area of delaminated concrete.

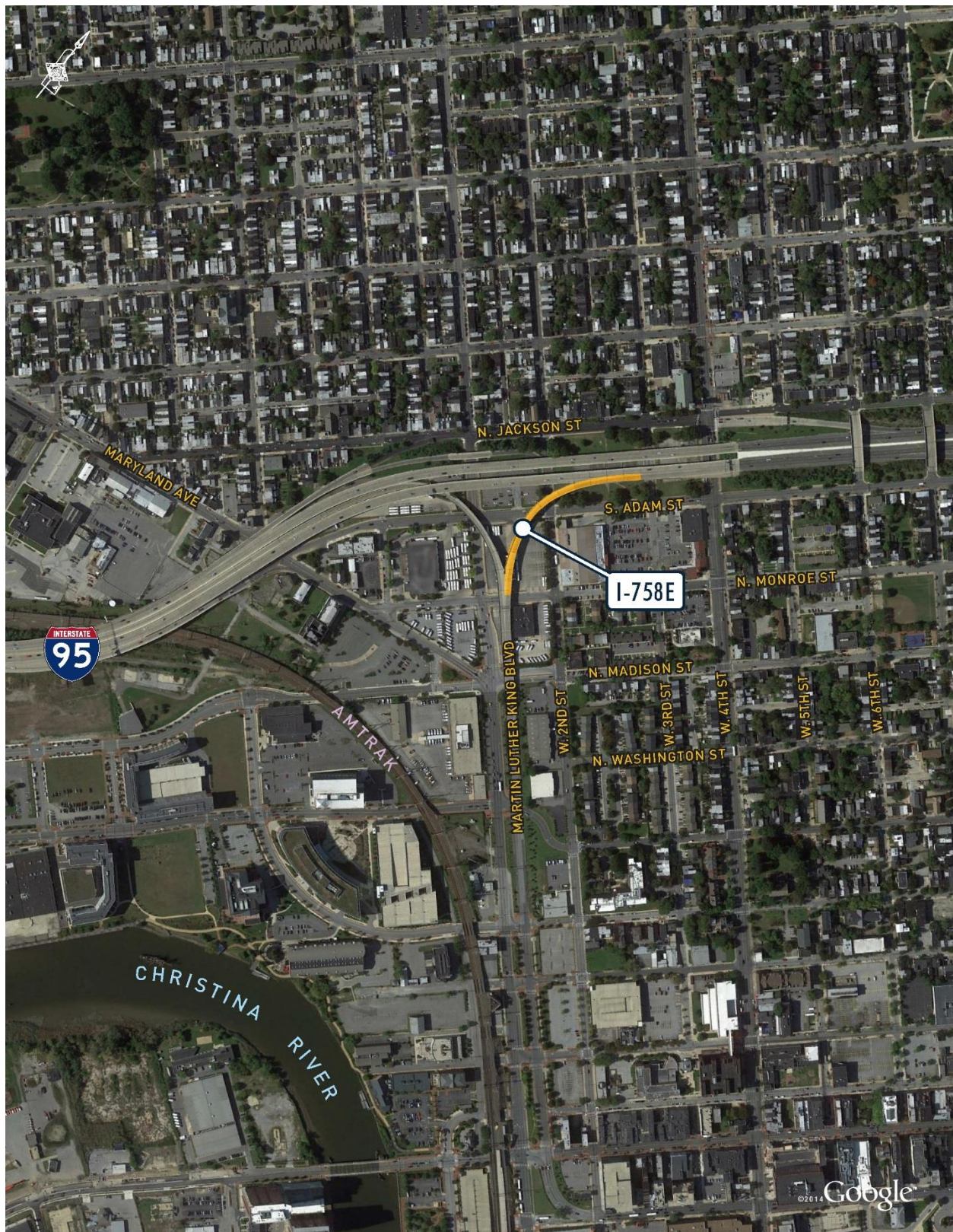
4.5 Bridge 1-758E

4.5.1 Bridge Description

Bridge 1-758E (Ramp E) is a ramp from Martin Luther King Jr. Boulevard Ramp (BR 1-758H) to I-95 NB over N. Adams St. (see Location Map in Section 4.5.2). The structure is an eleven (11) span simply supported steel beam bridge built in 1976. The bridge has an overall length of 814.93'± with span lengths of 82'-0"±, 70'-0"±, 70'-0"±, 70'-0"±, 70'-0"±, 70'-10"±, 91'-1 ½"±, 91'-1 ½"±, 60'-5"±, 69'-3 ½"±, and 70'-1 ½"±. The superstructure in Spans 1 – 5 consists of widened portions of Spans 51 – 55 of BR 1-748N. Spans 6 – 11 of the bridge have an out-to-out width that varies from 25'-8"± to 37'-6"± providing a clear roadway width that varies from 23'-0"± to 34'-10"±. The bridge carries one (1) lane of traffic from BR 1-758H to I-95 NB (BR 1-748N). Span 1 consists of a widened overhang of Span 55N of BR 1-748N. Span 2 consists of one (1) additional painted steel rolled beam with a welded cover plate, Span 3 consists of two (2) additional painted steel rolled beams with welded cover plates, Span 4 consists of three (3) additional painted steel rolled beams with welded cover plates, and Span 5 consists of four (4) additional painted steel rolled beams with welded cover plates. The beams at the widened spans support a 7½"± thick reinforced concrete deck. The existing deck in these widened spans is protected with a 2¼"± thick LMC overlay to match BR 1-748N. The superstructure in Spans 6 – 11 consists of three (3) spans of four (4) painted steel rolled beams with welded cover plates, two (2) spans of four (4) welded painted steel beams, and one (1) span of five (5) painted steel rolled beams with welded cover plates supporting an 8"± thick reinforced concrete deck. The outside barriers are 2'-8"± high jersey shape reinforced concrete parapets. The substructure consists of reinforced concrete columns with reinforced concrete pier caps in Spans 1 – 5 and reinforced concrete hammerhead piers in Spans 6 – 11. The structure shares a pier at the north end with BR 1-748N and a pier at the south end with BR 1-758H.

Note, the numbering convention used in this report follows the numbering convention used in the biennial inspection reports where the first span is numbered 1. This differs from the plans where the first span is numbered E11.

4.5.2 Location Map



4.5.3 NDE Plan

The bridge deck was surveyed using NDE methods in order to assess the condition of the structural concrete deck. The goal of the NDE program was to determine the structural concrete deck's remaining service life and the proposed approximate quantity of structural concrete deck repairs. The assessment was conducted using IE methodology in order to determine the location and severity of observed delaminations within the structural deck. The single lane in the northbound direction was surveyed using IE methodology. A 2' long x 2' wide grid was marked on the bridge deck using water soluble paint and the six (6) spans, or 6 "span-lanes" were tested.

4.5.3.1 NDE Results

The following is a summary of the NDE results. Delaminations are defined as predominately horizontal cracks found in the base structural deck. Results are presented with an IE deck condition rating from 0 to 100 (these are relative condition ratings with respect to each project bridges and cannot be compared to any other bridges) and an overall IE deck condition state of Good, Fair, Poor, or Serious, quantified by deck area percentage (%). Good (or "sound") is defined by the lack of delaminations within the base structural deck. Fair is defined as the potential presence of initial delamination described as occasional (local) separations within the deck. Poor is defined as the presence of a continuous delamination of a smaller width, relative to the depth, or thickness, of the deck. In many cases, it cannot be detected by chain drag or hammer sounding as it is often outside the audible range given the delamination is located deeper within the deck between the top and bottom mats of reinforcing steel. Serious is defined as a continuous delamination of a larger width, relative to the depth and is a result of flexural oscillations of the delaminated part of the deck. It is in the audible range. Areas of the deck in serious condition can be detected by chain drag or hammer sounding given the delamination is located at or near the top mat of reinforcing steel. Note that the IE deck condition states do not correlate with the NBI visual condition state ratings of 7, 5, 4, or 3, respectively. For further information and complete results, please reference the full NDE report in Appendices B and C.

This bridge has no overlay. On average, 33% of the deck area shows no signs of delamination. Approximately 56% is in a state of incipient delamination, which can be described as a state where there are signs of a discontinuous delamination (the deck has intermittent cracking, but is mostly connected). 11% of the deck area is in a state of fully developed delamination. Delaminations are more widespread in Spans 4 through 6. The majority of the delaminations are along the joints. The bridge deck is in fair to poor condition, with the poor condition at the northern end of the ramp.

4.5.4 Concrete Coring Plan

A total of four (4) 3.25" diameter concrete core samples, 5.50" to 7.50" long, were extracted and laboratory tested in accordance with ASTM C42. . Three (3) cores were tested for compressive strength in accordance with ASTM C39, one (1) of which was additionally tested for water soluble chloride ions in accordance with ASTM C1218. One (1) core was sent to Highbridge Materials Consulting, Inc. for petrographic examination and air-void analysis in accordance with ASTM C856 and ASTM C457, respectively.

4.5.4.1 Concrete Core Results

The following is a summary of the concrete coring results; for further information, please reference the full report in Appendix D.

The design strength of the concrete deck is 3000 psi. The tested cores resulted in an average compressive strength of 5790 psi, with a range of 5440 psi to 6060 psi.

Three (3) depth results in the base structural deck (0.5", 1", and 2") were obtained from the water soluble chloride ion core sample. The top layer of steel is located at 1.5" according to the plans. The chloride content is 0.16 lbs./c.y at the 0.5" depth, 0.03 lbs./c.y. at the 1" depth, and 0.00 lbs./c.y. at the 2" depth. In accordance with DelDOT's Bridge Design Manual May 2005 Figure 9-1, a level of chloride contamination

from 0 to 1.3 is considered low, 1.3 to 2.0 is considered moderate, and greater than 2.0 is considered advanced. Therefore chloride contamination in the upper and lower layers is considered low.

4.5.4.2 Petrographic Analysis Results

Core 758E-1P was sent to Highbridge Materials Consulting, Inc. for petrographic and air voids analysis. The following is a summary of the test results. The following is a summary of the test results. For further information please reference the "*Petrographic Examination Report*" prepared by Highbridge Materials Consulting, Inc. dated March 22, 2015, in Appendix E.

The petrographic analysis of the core indicated that the concrete materials were generally well mixed. There was a minor indication of possible shortened mixing time or the addition of water after mixing. However, these indications are very minor and not something of concern. The concrete also appears to have been cast and consolidated in accordance with industry acceptable practices. The water to cement ratio for the core is estimated to be in the mid to high 0.40's. The core had evidence of early stage ASR in the form of axial micro-cracking. However, the reaction is in its very early stages and does not impose an imminent threat to the stability of the concrete.

The total air voids observed in core 758E-1P was 5.2%. Current specifications for concrete exposed to freezing and thawing cycles, per ACI 318 Chapter 4 Section 4, are considered within acceptable limits from 3.5% to 6.5%. The results for this core were found to be in compliance with this specification.

4.5.5 Paint Adhesion Testing

Paint adhesion testing was performed on pre-selected locations throughout the viaduct on representative areas of distressed or peeling paint, in addition to areas where the coating system was intact. A NACE Level 1 certified inspector performed the test utilizing a portable adhesion tester in accordance with ASTM D4541. At each test location, the inspector documented a description of the failure (paint vs. adhesive), and the tensile strength (psi). Additionally, the inspector determined and recorded the coating thickness, utilizing an electronic dry film thickness gauge per the procedures outlined in SSPC-PA2. The variability of the testing results summarized in Appendix F suggests further testing locations are required. After consultation with the Department, it was agreed the entire superstructure will be repainted.

4.5.6 Summary of Findings

The following is a summary of the visual inspection findings; for further information, please reference the inspection field observation notes in Appendix H.

The concrete deck has no visible defects. The deck joints exhibit debonded, depressed or torn seal material, are filled with debris, and the steel armoring exhibits surface corrosion and scrapes. The drainage basin is clear and functional. The beams exhibit random areas of freckled corrosion; the ends exhibit minor to severe corrosion (see Photo 1), predominately to the top flange edges. The webs and bearing stiffeners exhibit up to $\frac{1}{8}$ " painted over pitting (see Photo 2). Steel diaphragms exhibit minor to severe corrosion at the piers, and random areas of peeling paint with exposed primer to the bottom flanges throughout. The bearings exhibit minor corrosion to the plate edges, $\frac{1}{4}$ " rust delaminations (see Photo 4), sheared anchor bolts (see Photo 5), $\frac{1}{8}$ " pack rust between plates (see Photo 6), up to $\frac{1}{4}$ " pack rust between masonry plates and pedestals, and misalignment of masonry plates with up to $\frac{3}{4}$ " overhanging the pedestal (see Photo 7). The concrete piers exhibit cracks with corrosion stains, delaminations, and spalls with exposed corroded steel reinforcement (see Photo 8).

4.5.6.1 Defect Photographs

The defect photos are representative of the as-inspected condition; additional photos are available upon request.



Photo 1: Typical light corrosion at bottom flange near beam end (Span 1, Beam 3 at Pier 11)



Photo 2: Typical 1/8" pitting (Span 3, Beam 4 at Pier 9)



Photo 3: 1/8" gap between bottom flange and sole plate (Span 5, Beam 4 at Pier 8)



Photo 4: Typical bearing corrosion and rust delaminations (Span 3, Beam 4 at Pier 9)



Photo 5: North anchor bolt sheared off (Span 1, Bearing 5 at Pier 12)



Photo 6: Pack rust between sole and fill plate, deforming fill plate (Span 3, Bearing 1 at Pier 10)



Photo 7: Masonry plate overhanging pedestal 3/4-inches (Span 5, Bearing 1 at Pier 8)



Photo 8: Spall with exposed corroded steel reinforcement (Pier 6, East Face)

4.5.7 Defect Tables

BR 1-758E Deck Defects – Deck to be replaced.

BR 1-758E Superstructure Defects

Defect Number	Location	Description
S-1-1	Span 1, Pier 12 Bearings	1/2-inch pack rust between sole and fill plates, deforming the fill plates upward.
S-1-2	Span 1, Pier 12, Bearing 5	North anchor bolt sheared off.
S-3-1	Span 3, Pier 10, Bearings 1 & 2	3/4-inch pack rust between sole and fill plates, deforming the fill plates upward.
S-4-1	Span 4, Pier 8 Bearings	North faces overhang the pedestals up to 1/2-inch. Bearings are pushing outward against south keeper plate.
S-5-1	Span 5, Pier 8 Bearings	North faces overhang the pedestals up to 3/4-inch.
S-5-2	Span 5, Pier 8, Bearings 3 & 4	1/8" gap between bottom flange and sole plate with pack rust (see Photo 3).
S-5-3	Span 5, Pier 7, Bearing 4	Expanded at 35 degrees Fahrenheit.

BR 1-758E Substructure Defects

Defect Number	Location	Description
P-6-1	Pier 6, North Face below Bay 3, East Overhang	7" wide x 8" high area of delaminated concrete.
P-6-2	Pier 6, East Face	2-3" wide x 1'-1" high x 1" deep spall that extends 5" onto the top face. Active leakage with water directly on top of spall.
P-6-3	Pier 6, South Face below Bay 2	2'-9" wide x 2'-6" high x 1/2" deep spall.
P-6-4	Pier 6, South Face below Pedestal 4	3'-1" wide x 1'-0" high area of delaminated concrete with spalling up to 2" deep.
P-6-5	Pier 6, West Face	3" wide x 11" high x 1/2" deep spall.
P-6-6	Pier 6, Underside of Cap, West Overhang	2'-2" wide x 1'-0" high area of delaminated concrete.
P-6-7	Pier 6, Top of Cap, West End	8" wide x 4" long x 3/4" deep spall.
P-6-8	Pier 6, Top of Cap, West Overhang, Bay 1	1" wide x 1'-2" long x 1/2" deep spall.
P-6-9	Pier 6, Top of Cap, Bay 2	9" wide x 2'-1" long area of delaminated concrete.
P-7-1	Pier 7, North Face of East Overhang	1'-4" wide x 1'-4" high area of delaminated concrete.
P-7-2	Pier 7, North Face below Bay 2	1'-6" high x 4" wide area of delaminated concrete with corrosion stains.

BR 1-758E Substructure Defects

Defect Number	Location	Description
P-7-3	Pier 7, North Face below Bay 2	1'-6" wide x 8" high area of delaminated concrete.
P-7-4	Pier 7, North Face of stem, 5'-0" feet above ground	1'-6" wide x 2'-6" high area of delaminated concrete
P-7-5	Pier 7, South Face of stem, 20'-0" feet above the ground	4" wide x 1'-4" high area of delaminated concrete.
P-7-6	Pier 7, South Face of East Overhang, below Bay 3	4" wide x 8" high area of delaminated concrete.
P-7-7	Pier 7, South Face of East Overhang, below Bay 3	1'-0" wide x 3" high area of delaminated concrete.
P-8-1	Pier 8, North Face of stem	11" wide x 3'-7" high area of delaminated concrete.
P-8-2	Pier 8, North Face of stem	1'-2" wide x 3'-6" high area of delaminated concrete.
P-8-3	Pier 8, Underside of Cap, North Overhang	2'-2" wide x 11" high area of delaminated concrete.
P-8-4	Pier 8, East Face of stem	11" wide x 4'-4" high area of delaminated concrete.
P-8-5	Pier 8, East Face of stem	6" wide x 1'-3" high area of delaminated concrete.
P-9-1	Pier 9, East Face of stem	1'-1" wide x 2'-0" high area of delaminated concrete.
P-9-2	Pier 9, East Face below Bay 2	1'-0" wide x 1'-2" high area of delaminated concrete.
P-9-3	Pier 9, East Face below Bay 2	1'-11" wide x 2'-1" high area of delaminated concrete.
P-9-4	Pier 9, East Face below Bay 2	1'-0" wide x 1'-4" high area of delaminated concrete.
P-9-5	Pier 9, East Face below Pedestal 3	1'-3" wide x 1'-11" high area of delaminated concrete.
P-9-6	Pier 9, Underside of Cap, North Overhang	1'- 1" wide x 2'-0" high area of delaminated concrete.
P-9-7	Pier 9, North Face	1'-6" high x 1/16" wide vertical crack.
P-9-8	Pier 9, West Face of stem	4" wide x 5" high area of delaminated concrete.
P-9-9	Pier 9, West Face of stem	10" wide x 6" high area of delaminated patch.
P-9-10	Pier 9, West Face of stem	2'-2" high x 1/16" wide vertical crack.
P-9-11	Pier 9, West Face of North Overhang	9" wide x 9" high area of delaminated concrete.

BR 1-758E Substructure Defects (Continued)

Defect Number	Location	Description
P-9-12	Pier 9, West Face of North Overhang	1'-10" wide x 8" high area of delaminated concrete.
P-10-1	Pier 10, East Face, North End	1'-2" wide x 7" high area of delaminated concrete that extends 4" onto the top face.
P-10-2	Pier 10, Top Face of Pedestal 2	Two (2) 7" long x 1/16" wide cracks.
P-10-3	Pier 10, Top Side of Pedestal 2	2'-0" long x 1/16" wide horizontal crack.
P-10-4	Pier 10, Top Face of Pedestal 3	5" wide x 1'-2" long x 3/4" deep spall.
P-10-5	Pier 10, Top Face, Bay 1	1'-0" wide x 2'-0" long area of 1/16-inch wide map cracking.
P-11-1	Pier 11, East Face, South Overhang	1 1/2" wide x 5" high x 3/4" deep spall located on edge of existing patch.
P-11-2	Pier 11, East Face, North Overhang	4'-8" wide x 9" high area of delaminated patch.
P-11-3	Pier 11, East Face of stem	1'-1" wide x 1'-6" high area of delaminated concrete.
P-11-4	Pier 11, East Face of stem	9" wide x 1'-0" high area of delaminated concrete.
P-11-5	Pier 11, East Face of stem	4" wide x 1'-7" high area of delaminated concrete.
P-11-6	Pier 11, East Face of stem	8" wide x 7" high x 1/2" deep spall.
P-11-7	Pier 11, Top Face, Bay 1	2'-0" wide x 2'-0" long area of delaminated concrete.
P-11-8	Pier 11, Top Face, Bay 2	1'-6" wide x 1'-0" long area of delaminated concrete.

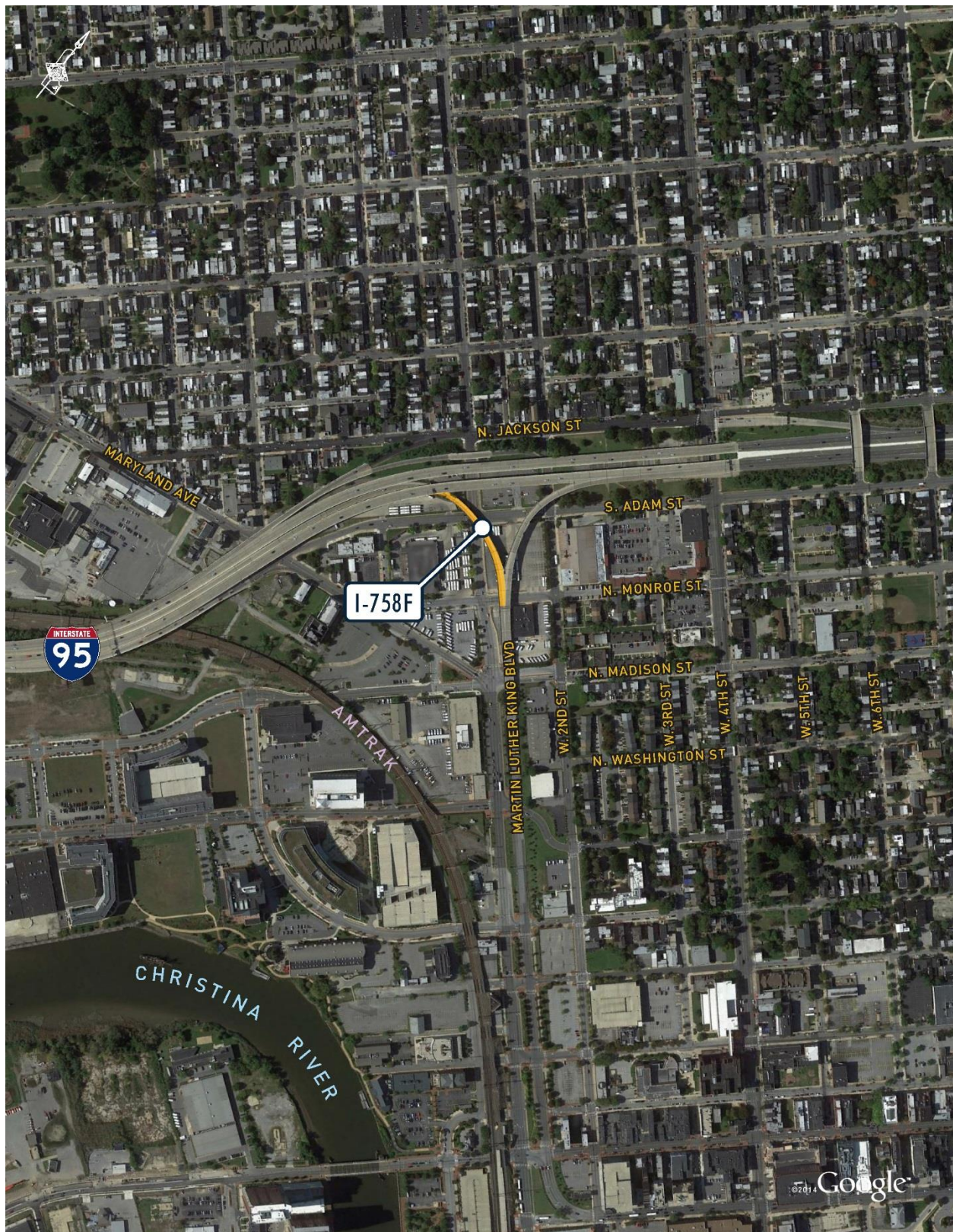
4.6 Bridge 1-758F

4.6.1 Bridge Description

Bridge 1-758F (Ramp F) is a ramp from Martin Luther King Jr. Boulevard Ramp (BR 1-758H) to I-95 SB over Adams St. and Lancaster Ave. (see Location Map in Section 4.6.2). This structure is a four (4) span simply supported steel beam bridge built in 1977. The bridge has an overall length of 362'-4¼"± with span lengths of 65'-7¾"±, 135'-0¼"±, 77'-7¼", and 84'-1"±. The bridge has an out-to-out width of 25'-8"± providing a clear roadway width of 23'-0"±. The bridge carries one (1) lane of traffic from ramp BR 1-758H towards BR 1-758G. Spans 1 – 3 consist of four (4) painted steel plate girders supporting an 8"± thick reinforced concrete deck. Span 4 consists of four (4) painted steel rolled beams with welded cover plates supporting an 8"± thick reinforced concrete deck. There is no existing overlay on the deck. The outside barriers are 2'-8"± high jersey shape reinforced concrete parapets. The substructure consists of reinforced concrete hammerhead piers and a reinforced concrete abutment at the south end of the bridge. There is a 60'-0" long U-wall at the south end of the bridge that leads to an at-grade portion of roadway between BR 1-758F and BR 1-758G.

Note, the numbering convention used in this report follows the numbering convention used in the biennial inspection reports where the first span is numbered 1. This differs from the plans where the first span is numbered F1.

4.6.2 Location Map



4.6.3 NDE Plan

The bridge deck was surveyed using NDE methods in order to assess the condition of the structural concrete deck. The goal of the NDE program was to determine the structural concrete deck's remaining service life and the proposed approximate quantity of structural concrete deck repairs. The assessment was conducted using IE methodology in order to determine the location and severity of observed delaminations within the structural deck. The single lane in the southbound direction was surveyed using IE methodology. A 2' long x 2' wide grid was marked on the bridge deck using water soluble paint and the four (4) spans, or 4 "span-lanes" were tested.

4.6.3.1 NDE Results

The following is a summary of the NDE results. Delaminations are defined as predominately horizontal cracks found in the base structural deck. Results are presented with an IE deck condition rating from 0 to 100 (these are relative condition ratings with respect to each project bridges and cannot be compared to any other bridges) and an overall IE deck condition state of Good, Fair, Poor, or Serious, quantified by deck area percentage (%). Good (or "sound") is defined by the lack of delaminations within the base structural deck. Fair is defined as the potential presence of initial delamination described as occasional (local) separations within the deck. Poor is defined as the presence of a continuous delamination of a smaller width, relative to the depth, or thickness, of the deck. In many cases, it cannot be detected by chain drag or hammer sounding as it is often outside the audible range given the delamination is located deeper within the deck between the top and bottom mats of reinforcing steel. Serious is defined as a continuous delamination of a larger width, relative to the depth and is a result of flexural oscillations of the delaminated part of the deck. It is in the audible range. Areas of the deck in serious condition can be detected by chain drag or hammer sounding given the delamination is located at or near the top mat of reinforcing steel. Note that the IE deck condition states do not correlate with the NBI visual condition state ratings of 7, 5, 4, or 3, respectively. For further information and complete results, please reference the full NDE report in Appendices B and C.

This bridge has no overlay. On average, 34% of the deck area shows no signs of delamination. Approximately 58% is in a state of incipient delamination, which can be described as a state where there are signs of a discontinuous delamination (the deck has intermittent cracking, but is mostly connected). 8% of the deck area is in a state of fully developed delamination. Overall, the deck is in fair condition, with no significant differences in the condition between the spans. Delamination is randomly distributed along the ramp.

4.6.4 Concrete Coring Plan

A total of four (4) 3.25" diameter concrete core samples, 4.63" to 7.25" long, were extracted and laboratory tested in accordance with ASTM C42. Three (3) cores were tested for compressive strength in accordance with ASTM C39, one (1) of which was additionally tested for water soluble chloride ions in accordance with ASTM C1218. One (1) core was sent to Highbridge Materials Consulting, Inc. for petrographic examination and air-void analysis in accordance with ASTM C856 and ASTM C457, respectively.

Due to observed deficiencies in the reinforced concrete abutments of Bridges 1-758F and 1-758G, inspection and testing crews were on site on March 2, 2015 to obtain concrete core samples from each abutment. A total of two (2) 3.25" diameter concrete samples, 5.35" to 5.99" long, were extracted and laboratory tested in accordance with ASTM C42. Both cores were tested for compressive strength in accordance with ASTM C39 and for water soluble chloride ions in accordance with ASTM C1218.

4.6.4.1 Concrete Core Results

The following is a summary of the concrete coring results; for further information, please reference the full report in Appendix D.

The design strength of the concrete deck is 3000 psi. The tested cores resulted in an average compressive strength of 5110 psi, with a range of 4870 psi to 4230 psi. The design strength of the abutment is 3000 psi. The tested abutment cores resulted in an average compressive strength of 4050 psi, with a range of 3560 psi to 4540 psi.

Three (3) depth results in the base structural deck (0.5", 1", and 2") were obtained from the water soluble chloride ion core sample. The top layer of steel is located at 1.5" according to the plans. The chloride content is 0.18 lbs./c.y. at the 0.5" depth, 0.03 lbs./c.y. at the 1" depth, and 0.00 lbs./c.y. at the 2" depth. In accordance with DelDOT's Bridge Design Manual May 2005 Figure 9-1, a level of chloride contamination from 0 to 1.3 is considered low, 1.3 to 2.0 is considered moderate, and greater than 2.0 is considered advanced. Therefore chloride contamination in the upper and lower layers is considered low.

Two (2) depth results in the abutment (1" and 2") were obtained from the water soluble chloride ion core samples. The average chloride content is 0.175 lbs./c.y. at the 1" depth and 0.07 lbs./c.y. at the 2" depth. In accordance with DelDOT's Bridge Design Manual May 2005 Figure 9-1, a level of chloride contamination from 0 to 1.3 is considered low, 1.3 to 2.0 is considered moderate, and greater than 2.0 is considered advanced. Therefore chloride contamination is considered low.

4.6.4.2 Petrographic Analysis Results

Core 758F-1P was sent to Highbridge Materials Consulting, Inc. for petrographic and air voids analysis. The following is a summary of the test results. For further information please reference the "*Petrographic Examination Report*" prepared by Highbridge Materials Consulting, Inc. dated March 22, 2015, in Appendix E.

The petrographic analysis of the core indicated that the concrete materials were generally well mixed. There was a minor indication of possible shortened mixing time or the addition of water after mixing. However, these indications are very minor and not something of concern. The concrete also appears to have been cast and consolidated in accordance with industry standard practices. The water to cement ratio for the core is estimated to be in the mid to high 0.40's. The core had trace evidence of early stage ASR in the form of axial micro-cracking. However, the reaction is in its very early stages and does not impose an imminent threat to the stability of the concrete.

The total air voids observed in core 758F-1P was 6.5%. Current specifications for concrete exposed to freezing and thawing cycles, per ACI 318 Chapter 4 Section 4, are considered within acceptable limits from 3.5% to 6.5%. The results for this core were found to be at the upper limit of this specification.

4.6.5 Paint Adhesion Testing

Paint adhesion testing was performed on pre-selected locations throughout the viaduct on representative areas of distressed or peeling paint, in addition to areas where the coating system was intact. A NACE Level 1 certified inspector performed the test utilizing a portable adhesion tester in accordance with ASTM D4541. At each test location, the inspector documented a description of the failure (paint vs. adhesive), and the tensile strength (psi). Additionally, the inspector determined and recorded the coating thickness, utilizing an electronic dry film thickness gauge per the procedures outlined in SSPC-PA2. The variability of the testing results summarized in Appendix F suggests further testing locations are required. After consultation with the Department, it was agreed the entire superstructure will be repainted.

4.6.6 Summary of Findings

The following is a summary of the visual inspection findings; for further information, please reference the inspection field observation notes in Appendix H.

The concrete deck has no visible defects. The deck joints exhibit debonded, depressed or torn material, are filled with debris, and the steel armoring exhibits surface corrosion and scrapes. The drainage basin is 20% clogged with debris and functional. The beams exhibit random areas of freckled corrosion; the ends

exhibit minor to severe corrosion (see Photo 1), predominately to the top flange edges. The webs and bearing stiffeners exhibit up to 1/8" painted over pitting. Steel diaphragms exhibit minor to severe corrosion at the piers, and random areas of freckled corrosion and peeling paint with exposed primer to the bottom flanges throughout (see Photo 2). The bearings typically exhibit minor corrosion to the plate edges, 1/4" rust delaminations (see Photo 3), 1/8" pack rust between plates (see Photo 4), and up to 1/4" pack rust between masonry plates and pedestals. The concrete abutment and piers exhibit cracks with corrosion stains and delaminations. The abutment exhibits widespread hairline map cracking with corrosion stains.

4.6.6.1 Defect Photographs

The defect photos are representative of the as-inspected condition; additional photos are available upon request.



Photo 1: Typical beam end corrosion (Span 4, Beam 5 at Pier 4)



Photo 2: Typical interior diaphragm peeling paint (Span 4, Bay 4, Diaphragm 2)



Photo 3: Typical bearing corrosion, rust delaminations (Span 1, Bearing 4 at West Abutment)



Photo 4: Pack rust between masonry and shim plate preventing movement (Span 2, Bearing 1 at Pier 1)

4.6.7 Defect Tables

BR 1-758F Deck Defects – Deck to be replaced.

BR 1-758F Superstructure Defects

Defect Number	Location	Description
S-2-1	Span 2, Pier 1, Bearing 1	3/4-inch pack rust between masonry and shim plate on front face may prevent contraction.
S-3-1	Span 3, Pier 2, Bearing 4	1/2-inch pack rust between masonry and shim plate on front face may prevent contraction.

BR 1-758F Substructure Defects

Defect Number	Location	Description
A-1-1	West Abutment, Front Face below Beam 4	1'-0" wide x 9" high area of delaminated concrete.
A-1-2	West Abutment, Front Face	Hairline cracks throughout with and without efflorescence and corrosion staining.
P-1-1	Pier 1, Underside of Cap, South Overhang	9" wide x 2'-0" long area of delaminated concrete.
P-2-1	Pier 2, East Face of Cap, South Overhang	1'-8" wide x 8" high area of delaminated concrete.
P-2-2	Pier 2, West Face of Cap, South Overhang	11" wide x 10" high area of delaminated concrete.
P-2-3	Pier 2, West Face of Cap, North Overhang	3" diameter conduit for street signals is corroded with areas of 100% section loss throughout.

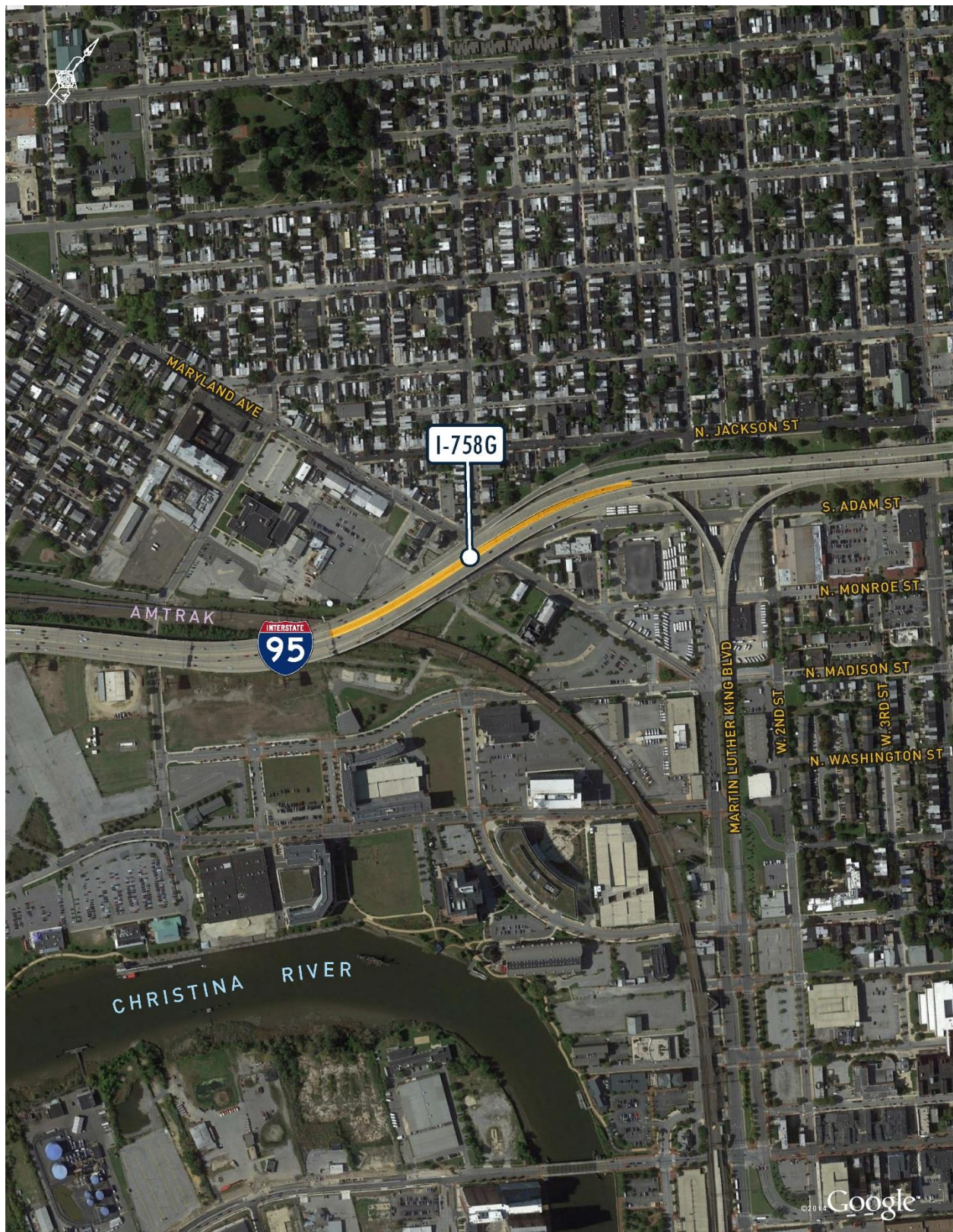
4.7 Bridge 1-758G

4.7.1 Bridge Description

Bridge 1-758G (Ramp F) is a ramp from Martin Luther King Jr. Boulevard Ramp to I-95 SB over Maryland Ave. (see Location Map in Section 4.7.2). This structure is a ten (10) span simply supported steel beam bridge built in 1977. The bridge has an overall length of 781.68'± with span lengths of 73'-4"±, 74'-2 ¾"±, 74'-1 ½"±, 74'-0"±, 74'-0"±, 74'-0"±, 137'-6"±, 64'-6"±, 68'-0"±, and 68'-0"±. The bridge has an out-to-out width of 25'-8"± providing a clear roadway width of 23'-0"±. The bridge carries one (1) lane of traffic from ramp BR 1-758F to I-95 SB. Spans 1 – 6 and 8 – 10 consist of four (4) painted steel rolled beams with welded cover plates and Span 7 consists of four (4) welded painted steel beams supporting an 8"± thick reinforced concrete deck. There is no existing LMC overlay on the deck. The outside barriers are 2'-8"± high jersey shape reinforced concrete parapets. The substructure consists of reinforced concrete hammerhead piers and a reinforced concrete stub abutment at the north end. The structure shares a pier at the south end with BR 1-748. There is a 90'-0" long U-wall at the north end of the bridge that follows an at-grade portion of roadway between BR 1-758F and BR 1-758G.

Note, the numbering convention used in this report follows the numbering convention used in the biennial inspection reports where the first span is numbered 1. This differs from the plans where the first span is numbered F26

4.7.2 Location Map



4.7.3 NDE Plan

The bridge deck was surveyed using NDE methods in order to assess the condition of the structural concrete deck. The goal of the NDE program was to determine the structural concrete deck's remaining service life and the proposed approximate quantity of structural concrete deck repairs. The assessment was conducted using IE methodology in order to determine the location and severity of observed delaminations within the structural deck. The single lane in the southbound direction was surveyed using IE methodology. A 2' long x 2' wide grid was marked on the bridge deck using water soluble paint and the ten (10) spans, or 10 "span-lanes" were tested.

4.7.3.1 NDE Results

The following is a summary of the NDE results. Delaminations are defined as predominately horizontal cracks found in the base structural deck. Results are presented with an IE deck condition rating from 0 to 100 (these are relative condition ratings with respect to each project bridges and cannot be compared to any other bridges) and an overall IE deck condition state of Good, Fair, Poor, or Serious, quantified by deck area percentage (%). Good (or "sound") is defined by the lack of delaminations within the base structural deck. Fair is defined as the potential presence of initial delamination described as occasional (local) separations within the deck. Poor is defined as the presence of a continuous delamination of a smaller width, relative to the depth, or thickness, of the deck. In many cases, it cannot be detected by chain drag or hammer sounding as it is often outside the audible range given the delamination is located deeper within the deck between the top and bottom mats of reinforcing steel. Serious is defined as a continuous delamination of a larger width, relative to the depth and is a result of flexural oscillations of the delaminated part of the deck. It is in the audible range. Areas of the deck in serious condition can be detected by chain drag or hammer sounding given the delamination is located at or near the top mat of reinforcing steel. Note that the IE deck condition states do not correlate with the NBI visual condition state ratings of 7, 5, 4, or 3, respectively. For further information and complete results, please reference the full NDE report in Appendices B and C.

This bridge has no overlay, with the exception of Span 1 (at the north end), that has a 1.5" thick overlay. On average, 53% of the deck area shows no signs of delamination. Approximately 37% is in a state of incipient delamination, which can be described as a state where there are signs of a discontinuous delamination (the deck has intermittent cracking, but is mostly connected). 9% of the deck area is in a state of fully developed delamination. The right side of the bridge, in the southbound direction, shows more signs of delamination. There are significant differences in the deck condition between the ten (10) spans, with the percentage of the fully delaminated area varying between 3% and 18% percent. Overall, the condition of the deck is fair to poor.

4.7.4 Concrete Coring Plan

A total of four (4) 3.25" diameter concrete core samples, 6.5" to 7" long, were extracted and laboratory tested in accordance with ASTM C42. Three (3) cores were tested for compressive strength in accordance with ASTM C39, one (1) of which was additionally tested for water soluble chloride ions in accordance with ASTM C1218. One (1) core was sent to Highbridge Materials Consulting, Inc. for petrographic examination and air-void analysis in accordance with ASTM C856 and ASTM C457, respectively. One (1) 3" diameter core hole was drilled through the overlay in Span 1 and pull testing was performed on the overlay in accordance with ASTM C1583.

Due to observed deficiencies in the reinforced concrete abutments of Bridges 1-758F and 1-758G, inspection and testing crews were on site on March 2, 2015 to obtain concrete core samples from each abutment. A total of four (4) 3.25" diameter concrete samples, 3.15" to 6.35" long, were extracted and laboratory tested in accordance with ASTM C42. All four (4) cores were tested for compressive strength in accordance with ASTM C39 and for water soluble chloride ions in accordance with ASTM C1218.

4.7.4.1 Concrete Core Results

The following is a summary of the concrete coring results; for further information, please reference the full report in Appendix D.

The design strength of the concrete deck is 3000 psi. The tested cores resulted in an average compressive strength of 6050 psi, with a range of 4900 psi to 6670 psi. The design strength of the abutment is 3000 psi. The tested abutment cores resulted in an average compressive strength of 4363 psi, with a range of 3970 psi to 4890 psi.

Three (3) depth results in the base structural deck (0.5", 1", and 2") were obtained from the water soluble chloride ion core sample. The top layer of steel is located at 1.5" according to the plans. The chloride content is 0.21 lbs./c.y. at the 0.5" depth, 0.09 lbs./c.y. at the 1" depth, and 0.01 lbs./c.y. at the 2" depth. In accordance with DelDOT's Bridge Design Manual May 2005 Figure 9-1, a level of chloride contamination from 0 to 1.3 is considered low, 1.3 to 2.0 is considered moderate, and greater than 2.0 is considered advanced. Therefore chloride contamination in the upper and lower layers is considered low.

Two (2) depth results in the abutment (1" and 2") were obtained from the water soluble chloride ion core samples. The average chloride content is 0.04 lbs./c.y. at the 1" depth and 0.02 lbs./c.y. at the 2" depth. In accordance with DelDOT's Bridge Design Manual May 2005 Figure 9-1, a level of chloride contamination from 0 to 1.3 is considered low, 1.3 to 2.0 is considered moderate, and greater than 2.0 is considered advanced. Therefore chloride contamination is considered low.

Failure of the pull test occurred at 141 psi, with the failure plane noted between the overlay wearing surface and the structural slab bond line. This core was above the ICRI recommended bond strength of 100 psi.

4.7.4.2 Petrographic Analysis Results

Core 758G-1P was sent to Highbridge Materials Consulting, Inc. for petrographic and air voids analysis. The following is a summary of the test results. For further information please reference the "*Petrographic Examination Report*" prepared by Highbridge Materials Consulting, Inc. dated March 22, 2015, in Appendix E.

The petrographic analysis of the core indicated that the concrete materials were generally well mixed. There was a minor indication of possible shortened mixing time or the addition of water after mixing. However, these indications are very minor and not something of concern. The concrete also appears to have been cast and consolidated in accordance with industry standard practices. The water to cement ratio for the core is estimated to be in the mid to high 0.40's. The core had trace evidence of early stage ASR in the form of axial micro-cracking. However, the reaction is in its very early stages and does not impose an imminent threat to the stability of the concrete.

The total air voids observed in core 758G-1P was 5.9%. Current specifications for concrete exposed to freezing and thawing cycles, per ACI 318 Chapter 4 Section 4, are considered within acceptable limits from 3.5% to 6.5%. The results for this core were found to be within this specification.

4.7.5 Paint Adhesion Testing

Paint adhesion testing was performed on pre-selected locations throughout the viaduct on representative areas of distressed or peeling paint, in addition to areas where the coating system was intact. A NACE Level 1 certified inspector performed the test utilizing a portable adhesion tester in accordance with ASTM D4541. At each test location, the inspector documented a description of the failure (paint vs. adhesive), and the tensile strength (psi). Additionally, the inspector determined and recorded the coating thickness, utilizing an electronic dry film thickness gauge per the procedures outlined in SSPC-PA2. The variability of the testing results summarized in Appendix F suggests further testing locations are required. After consultation with the Department, it was agreed the entire superstructure will be repainted.

4.7.6 Summary of Findings

The following is a summary of the visual inspection findings; for further information, please reference the inspection field observation notes in Appendix H.

The concrete deck exhibits spalls along the joints and Span 5 exhibits a spall with exposed corroded steel reinforcement (see Photo 1). The deck joints exhibit debonded, depressed or torn material, are filled with debris, and the steel armoring exhibits surface corrosion and scrapes. 1 of 3 scuppers are 100% clogged with debris and not functional. The beams and girders exhibit random areas of freckled corrosion; the ends exhibit minor to severe corrosion (see Photo 2), predominately to the top flange edges. The webs and bearing stiffeners exhibit up to 1/4" painted over pitting. Steel diaphragms exhibit minor to severe corrosion at the piers, and random areas of freckled corrosion throughout. The bearings that are not greased typically exhibit minor corrosion to the plate edges, 1/4" rust delaminations, 1/8" pack rust between plates, and up to 1/4" pack rust between masonry plates and pedestals (Photo 3). Anchor bolt nuts exhibit up to 10% section loss. The concrete abutment and piers exhibit cracks with corrosion stains, delaminations, and spalls with exposed corroded steel reinforcement (see Photo 5). The abutment exhibits widespread hairline map cracking with corrosion stains.

4.7.6.1 Defect Photographs

The defect photos are representative of the as-inspected condition; additional photos are available upon request.



Photo 1: Spall in deck with exposed corroded steel (Span 5, 2/3 span)



Photo 2: Typical beam end corrosion and pitting (Span 7, Beam 4 at Pier 6)



Photo 3: Typical bearing corrosion and anchor bolt nut section loss (Span 8, Bearing 4 at Pier 8)



Photo 4: Bottom flange gouge with curled steel (Span 9, Beam 1)



Photo 5: Spalls with exposed corroded steel reinforcement (South face of Pier 6)

4.7.7 Defect Tables

BR 1-758 G Deck Defects – Deck to be replaced.

BR 1-758 G Superstructure Defects

Defect Number	Location	Description
S-9-1	Span 9, Beam 1 between Diaphragm 2 and Pier 9	1 1/2" long x 7/8" wide x 3/16" deep gouge with curled steel and minor corrosion to the bottom flange underside.
S-10-1	Span 10, North Abutment Bearings	Expanded at 40 degrees Fahrenheit.

BR 1-758 G Substructure Defects

Defect Number	Location	Description
P-2-1	Pier 2, South Face	8'-0" long x 1/16" wide crack with corroded reinforcement.
P-3-1	Pier 3, North Face	2'-0" long x 1/16" wide crack.
P-3-2	Pier 3, North Face Corner to East Face Corner	5" wide x 1'-5" long area of delaminated concrete.
P-3-3	Pier 3, East Face	4'-2" long x 1/16" wide crack at top of Pier 3.
P-3-4	Pier 3, East Face	1'-0" long x 1/16" wide crack.
P-3-5	Pier 3, East Face	2" wide x 1'-5" long area of delaminated concrete.
P-3-6	Pier 3, South Face	4'-6" long x 1/16" wide crack at top west corner of south face of pedestal.
P-3-7	Pier 3, South Face	3'-6" long x 1/16" wide crack at west corner, approximately mid-height on pedestal.
P-3-8	Pier 3, South Face	3" wide x 3" long area of delaminated concrete at top east corner of south face.
P-3-9	Pier 3, South Face	4" wide x 3" high x 1/2" deep spall mid-height on south face.
P-3-10	Pier 3, South Face	2" wide x 1'-2" long x 1/2" deep spall located just below mid height on south face.
P-3-11	Pier 3, West Face	5'-7" long x 1/16" wide crack on top end of west elevation.
P-3-12	Pier 3, West Face	2'-0" long x 1/16" wide crack at north corner of west face.
P-3-13	Pier 3, Southwest Corner	7" wide x 2'-1" long area of delaminated concrete.
P-6-1	Pier 6, East Face	2'-0" long x 1/16" wide crack at mid-height of east face.

BR 1-758 G Substructure Defects (Continued)

Defect Number	Location	Description
P-6-2	Pier 6, East Face	5'-3" wide x 3' long area of delaminated concrete.
P-6-3	Pier 6, South Face	7" wide x 1'-0" long area of delaminated concrete.
P-6-4	Pier 6, South Face	1'-2" wide x 3'-2" long x 1" deep spall with exposed and corroded reinforcement.
P-6-5	Pier 6, South Face	1'-7" wide x 2'-5" long x 1" deep spall at west overhang with exposed and corroded reinforcement.
P-6-6	Pier 6, South Face	1'-8" wide x 3' long area of delaminated concrete at top of west overhang.
P-6-7	Pier 6, South Face	10" wide x 2'-9" long x 4" deep spall with exposed and corroded reinforcement.
P-6-8	Pier 6, Underside, East Pier Cap	7" wide x 1'-0" long x 3/4" deep spall.
P-7-1	Pier 7, Top Face at North Edge	10" wide x 2'-4" long area of delaminated concrete.
P-7-2	Pier 7, North Face	6" wide x 2'-0" long area of delaminated concrete.
P-7-3	Pier 7, North Face	6" wide x 1'-3" long area of delaminated concrete.
P-7-4	Pier 7, East Face	7" wide x 7" long area of delaminated concrete.
P-8-1	Pier 8, South Face, West Pier Cap	11" wide x 2'-0" long x 1 1/2" deep spall.
P-8-2	Pier 8, Underside, East Pier Cap	4" wide x 10" long area of delaminated concrete.
P-8-3	Pier 8, Topside	3'-0" long x 1/16" wide crack.
P-9-1	Pier 9, North Face, East Pier Cap	1'-2" wide x 1'-6" long area of delaminated concrete.
P-9-2	Pier 9, North Face, East Pier Cap	1'-2" wide x 1'-6" long area of delaminated concrete.
P-9-3	Pier 9, East Face	2'-6" wide x 3'-0" long x 2'-6" wide area of delaminated concrete.
P-9-4	Pier 9, South Face, East Pier Cap	1'-0" wide x 9" high area of delaminated concrete below Bay 3.
P-9-5	Pier 6, South Face	1'-7" wide x 2'-5" long x 1" deep spall at west overhang.
A-10-1	North Abutment, East Wingwall	1'-0" long x 1/16" wide crack.
A-10-2	North Abutment, East Wingwall	1'-4" long x 1/16" wide crack at East Wingwall, carrying over to south face.
A-10-3	North Abutment, South Face	2'-0" long x 1/16" crack at west corner.

BR 1-758 G Substructure Defects (Continued)

Defect Number	Location	Description
A-10-4	North Abutment, South Face	1'-4" long x 1/16" wide crack.
A-10-5	North Abutment, South Face	3'-4" long x 1/16" wide crack.
A-10-6	North Abutment, West Wingwall	6" long x 1/16" wide crack at mid-height
A-10-7	North Abutment, West Wingwall	1'-0" long x 1/16" wide crack near bottom of West Wingwall.

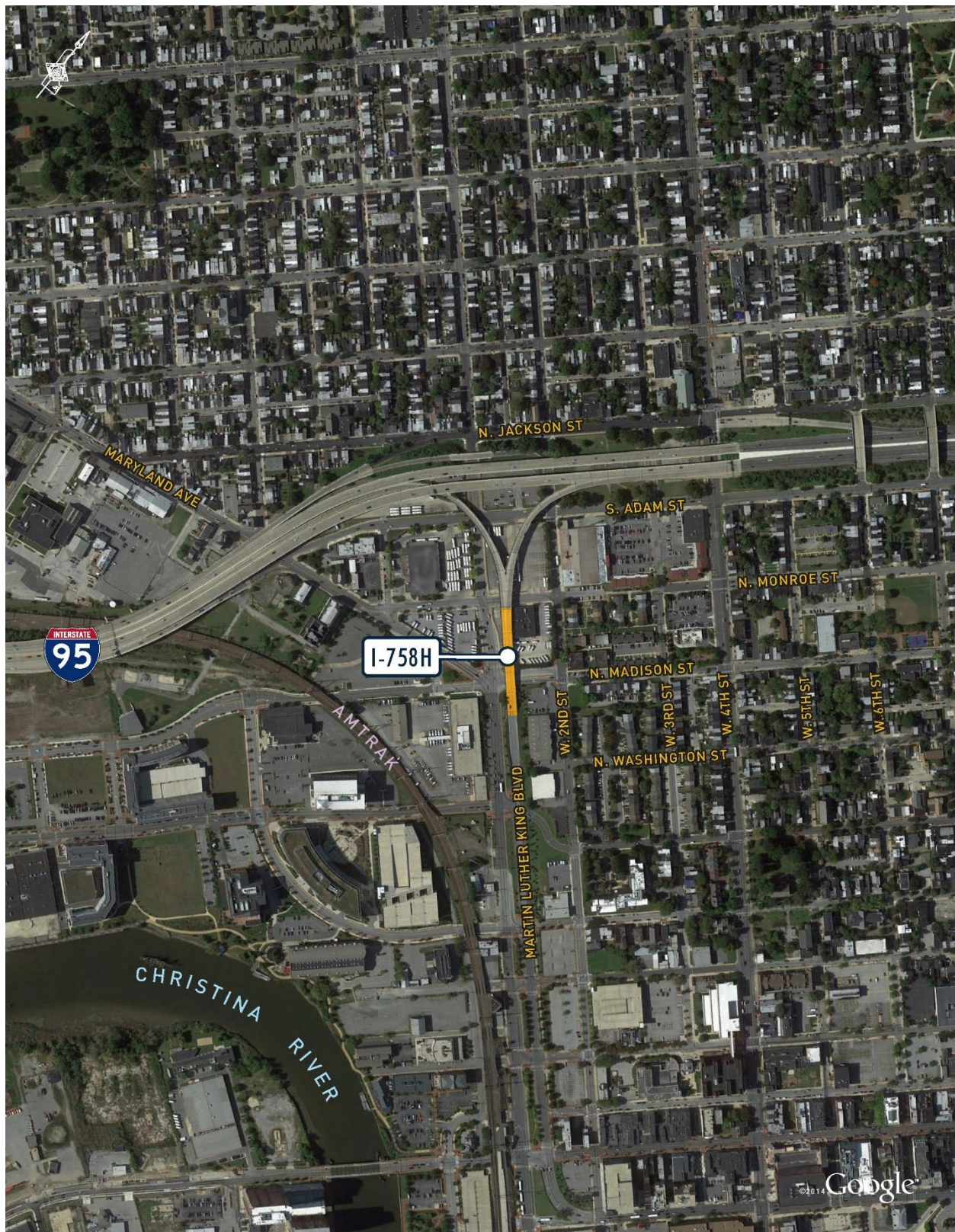
4.8 Bridge 1-758H

4.8.1 Bridge Description

Bridge 1-758H is a ramp from Martin Luther King Jr. Boulevard to I-95 over N. Madison St. and N. Monroe St. (see Location Map in Section. 4.8.2). This structure is a seven (7) span simply supported steel beam bridge built in 1976. The bridge has an overall length of 594'-3"± with span lengths of 88'-3"±, 87'-6"±, 87'-3"±, 83'-0"±, 83'-0"±, 83'-0"±, and 82'-3"±. The bridge has an out-to-out width that varies from 41'-8"± to 74'-7 ¾"± providing a clear roadway width that varies from 39'-0"± to 71'-11 ¾"±. The bridge carries two (2) lanes of traffic on Martin Luther King Jr. Boulevard towards ramps BR 1-758F and BR 1-758E to I-95. Span 1 consists of nine (9) painted steel rolled beams with welded cover plates, Span 2 consists of seven (7) painted steel rolled beams with welded cover plates and Spans 3 – 7 consists of six (6) painted steel rolled beams with welded cover plates, all supporting an 8"± thick reinforced concrete deck. There is no existing LMC overlay on the deck. The outside barriers are 2'-8"± high jersey shape reinforced concrete parapets. The substructure consists of reinforced concrete columns and pier caps and a reinforced concrete stub abutment at the east end. The structure shares a pier at the west end with ramps BR 1-758F and BR 1-758E.

Note, the numbering convention used in this report follows the numbering convention used in the biennial inspection reports where the first span is numbered 1. This differs from the plans where the first span is numbered EF1.

4.8.2 Location Map



4.8.3 NDE Plan

The bridge deck was surveyed using NDE methods in order to assess the condition of the structural concrete deck. The goal of the NDE program was to determine the structural concrete deck's remaining service life and the proposed approximate quantity of structural concrete deck repairs. The assessment was conducted using IE methodology in order to determine the location and severity of observed delaminations within the structural deck. The left and right lanes in the southbound direction were surveyed using IE methodology. A 2' long x 2' wide grid was marked on the bridge deck using water soluble paint and the seven (7) spans, or 14 "span-lanes" were tested.

4.8.3.1 NDE Results

The following is a summary of the NDE results. Delaminations are defined as predominately horizontal cracks found in the base structural deck. Results are presented with an IE deck condition rating from 0 to 100 (these are relative condition ratings with respect to each project bridges and cannot be compared to any other bridges) and an overall IE deck condition state of Good, Fair, Poor, or Serious, quantified by deck area percentage (%). Good (or "sound") is defined by the lack of delaminations within the base structural deck. Fair is defined as the potential presence of initial delamination described as occasional (local) separations within the deck. Poor is defined as the presence of a continuous delamination of a smaller width, relative to the depth, or thickness, of the deck. In many cases, it cannot be detected by chain drag or hammer sounding as it is often outside the audible range given the delamination is located deeper within the deck between the top and bottom mats of reinforcing steel. Serious is defined as a continuous delamination of a larger width, relative to the depth and is a result of flexural oscillations of the delaminated part of the deck. It is in the audible range. Areas of the deck in serious condition can be detected by chain drag or hammer sounding given the delamination is located at or near the top mat of reinforcing steel. Note that the IE deck condition states do not correlate with the NBI visual condition state ratings of 7, 5, 4, or 3, respectively. For further information and complete results, please reference the full NDE report in Appendices B and C.

This bridge has no overlay. On average, 55% of the deck area shows no signs of delamination. Approximately 40% is in a state of incipient delamination, which can be described as a state where there are signs of a discontinuous delamination (the deck has intermittent cracking, but is mostly connected). 5% of the deck area is in a state of fully developed delamination. There are no differences in the deck condition of the two lanes or between the spans. Delamination is generally randomly distributed, with several spans delaminated close to the joints. Overall, the deck is in fair condition.

4.8.4 Concrete Coring Plan

A total of four (4) 3.25" diameter concrete core samples, 3.5" to 7.5" long, were extracted and laboratory tested in accordance with ASTM C42. Three (3) cores were tested for compressive strength in accordance with ASTM C39, one (1) of which was additionally tested for water soluble chloride ions in accordance with ASTM C1218. One (1) core was sent to Highbridge Materials Consulting, Inc. for petrographic examination and air-void analysis in accordance with ASTM C856 and ASTM C457, respectively.

4.8.4.1 Concrete Core Results

The following is a summary of the concrete coring results; for further information, please reference the full report in Appendix D.

The design strength of the concrete deck is 3000 psi. The tested cores resulted in an average compressive strength of 5970 psi, with a range of 5230 psi to 6850 psi.

Three (3) depth results in the base structural deck (0.5", 1", and 2") were obtained from the water soluble chloride ion core sample. The top layer of steel is located at 1.5" according to the plans. The chloride content is 0.26 lbs./c.y. at the 0.5" depth, 0.06 lbs./c.y. at the 1" depth, and 0.01 lbs./c.y. at the 2" depth. In accordance with DelDOT's Bridge Design Manual May 2005 Figure 9-1, a level of chloride contamination

from 0 to 1.3 is considered low, 1.3 to 2.0 is considered moderate, and greater than 2.0 is considered advanced. Therefore chloride contamination in the upper and lower layers is considered low.

4.8.4.2 Petrographic Analysis Results

Core 758H-1P was sent to Highbridge Materials Consulting, Inc. for petrographic and air voids analysis. The following is a summary of the test results. For further information please reference the *"Petrographic Examination Report"* prepared by Highbridge Materials Consulting, Inc. dated March 22, 2015, in Appendix E.

The petrographic analysis of the core indicated that the concrete materials were generally well mixed. There was a minor indication of possible shortened mixing time or the addition of water after mixing. However, these indications are very minor and not something of concern. The concrete also appears to have been cast and consolidated in accordance with industry standard practices. The water to cement ratio for the core is estimated to be in the mid to high 0.40's. The core had trace evidence of early stage ASR in the form of axial micro-cracking. However, the reaction is in its very early stages and does not impose an imminent threat to the stability of the concrete.

The total air voids observed in core 758H-1P was 9.5%. Current specifications for concrete exposed to freezing and thawing cycles, per ACI 318 Chapter 4 Section 4, are considered within acceptable limits from 3.5% to 6.5%. The results for this core were significantly above this specified limit. Air void contents in this range usually result in lower compressive strengths. However, the compressive strength results for this structure indicated relatively high compressive strength.

4.8.5 Paint Adhesion Testing

Paint adhesion testing was performed on pre-selected locations throughout the viaduct on representative areas of distressed or peeling paint, in addition to areas where the coating system was intact. A NACE Level 1 certified inspector performed the test utilizing a portable adhesion tester in accordance with ASTM D4541. At each test location, the inspector documented a description of the failure (paint vs. adhesive), and the tensile strength (psi). Additionally, the inspector determined and recorded the coating thickness, utilizing an electronic dry film thickness gauge per the procedures outlined in SSPC-PA2. The variability of the testing results summarized in Appendix F suggest further testing locations are required. After consultation with the Department, it was agreed the entire superstructure will be repainted.

4.8.6 Summary of Findings

The following is a summary of the visual inspection findings; for further information, please reference the inspection field observation notes in Appendix H.

The concrete deck exhibits spalls in the soffit at the deck ends adjacent to the joints (see Photo 1). The deck joints exhibit debonded, depressed or torn material, are filled with debris, and the steel armoring exhibits surface corrosion and scrapes. 2 of 3 scuppers are 100% clogged with debris and not functional. The beams exhibit random areas of freckled corrosion; the ends exhibit minor to severe corrosion (see Photo 2), predominately to the top flange edges. The webs and bearing stiffeners exhibit up to 1/4" painted over pitting. Steel diaphragms exhibit minor to severe corrosion at the piers, and random areas of freckled corrosion throughout. The bearings that are not greased exhibit minor corrosion to the plate edges, 1/4" rust delaminations (see Photo 2), 1/8" pack rust between plates, and up to 1/4" pack rust between masonry plates and pedestals. The concrete abutment and piers exhibit cracks with corrosion stains, delaminations, and spalls with exposed corroded steel reinforcement (see Photo 4).

4.8.6.1 Defect Photographs

The defect photos are representative of the as-inspected condition; additional photos are available upon request.



Photo 1: Spall in soffit at joint with exposed corroded steel (Span 4, North Overhang at Pier 5)



Photo 2: Typical beam end and bearing corrosion (Spans 5 and 6, Beam 1 at Pier 5)



Photo 3: Concrete restricting proper movement (Span 3, Bearing 6 at Pier 3)



Photo 4: Delamination with up to 1/4" wide perimeter cracking (Pier 6, east face of cap below Beam 5)

4.8.7 Defect Tables

BR 1-758H Deck Defects – Spalls at deck ends will be replaced during joint replacement

BR 1-758H Superstructure Defects

Defect Number	Location	Description
S-3-1	Span 3, Bearing 6 at Pier 3	Concrete poured at front face around the bearing pad is preventing proper movement.
S-4-1	Span 4, Bay 3 at Midspan	1" diameter conduit is missing with exposed electrical wire hanging below Beam 5.
S-6-1	Span 6, Bay 3 between 2nd and 3rd Interior Diaphragms	Missing lighting attachment underneath bridge
S-6-2	Span 6, Bay 3 between 2nd and 3rd Interior Diaphragms	Conduit is detached and hanging 6" below the bottom flange

BR 1-758H Substructure Repair Defects

Defect Number	Location	Description
P-1-1	Pier 1, East Face of Cap south of Column 4	1'-4" wide x 5" high area of delaminated concrete.
P-1-2	Pier 1, West Face of Column 1	1'-0" wide x 2'-8" high area of delaminated concrete with minor spalling up to 1/4" deep.
P-1-3	Pier 1, West Face of Cap above Column 2	6" wide x 8" high x 1/2" deep spall with exposed corroded reinforcement.
P-1-4	Pier 1, West Face of Cap, South of Column 2	8" wide x 1'-0" high area of delaminated concrete.
P-1-5	Pier 1, West Face of Cap, South of Column 2	7" wide x 1'-1" high area of delaminated concrete.
P-1-6	Pier 1, West Face of Cap, South Overhang	1'-8" wide x 1'-1" high area of delaminated concrete.
P-1-7	Pier 1, Underside of Cap, North Overhang	8" wide x 2'-4" long area of delaminated concrete.
P-1-8	Pier 1, Underside of Cap between Columns 1 and 2	12-inch diameter area of delaminated concrete.
P-1-9	Pier 1, Underside of Cap between Columns 1 and 2	7" wide x 6" long area of delaminated concrete.
P-1-10	Pier 1, Underside of Cap between Columns 3 and 4	1'-5" wide x 3'-10" long area of delaminated concrete in a patch that extends up to 3" high on the west face.
P-1-11	Pier 1, Underside of Cap, Overhang south of Column 4	11" wide x 2'-2" long area of delaminated concrete.
P-2-1	Pier 2, East Face of Column 3	7" wide x 7" high area of delamination.
P-2-2	Pier 2, East Face of Cap above Column 3	1'-7" wide x 1'-0" high area of soft concrete in a patch with a 1'-0" wide x 8" area of delaminated concrete.
P-2-3	Pier 2, East Face of Cap between Columns 2 and 3	5" wide x 2'-0" high x 1/2" deep spall with exposed corroded reinforcement.
P-2-4	Pier 2, East Face of Cap between Columns 1 and 2	1'-3" long x 6" high area of delaminated concrete that extends up to 2" wide on the top face.
P-2-5	Pier 2, South Face, Column 2 at Top	9" wide x 3" high area of delaminated concrete.
P-2-6	Pier 2, South Face, Column 2 near mid-height	4" wide x 1'-7" high area of delaminated concrete that extends up to 2" wide on the west face.
P-2-7	Pier 2, West Face of Cap between Columns 2 and 3	1/16" wide x 2'-0" long horizontal crack.
P-2-8	Pier 2, West Face of Cap between Columns 1 and 2	1'-10" wide x 8" high area of delaminated concrete below Beam 4.
P-2-9	Pier 2, West Face of Cap between Columns 2 and 3	1'-5" wide x 10" high area of delaminated concrete below Beam 5.
P-2-10	Pier 2, West Face of Column 3	North anchor bolt for top downspout support strap missing.
P-2-11	Pier 2, West Face of Cap between Columns 2 and 3	1'-3" wide x 8" high area of delaminated concrete below Beam 6.

BR 1-758H Substructure Repair Defects (Continued)

Defect Number	Location	Description
P-2-12	Pier 2, West Face of Cap, South Overhang	1'-8" wide x up to 2'-5" high area of delaminated concrete.
P-2-13	Pier 2, Underside of Cap, North Overhang	2'-7" wide x 2'-0" long area of delaminated concrete.
P-2-14	Pier 2, Underside of Cap between Columns 1 and 2	1'-11" wide x 4'-1" long area of delaminated concrete.
P-2-15	Pier 2, Underside of Cap between Columns 1 and 2	10" wide x 1'-8" long area of delaminated concrete.
P-2-16	Pier 2, Underside of Cap between Columns 1 and 2	1'-0" wide x 1'-5" long area of delaminated concrete just north of Column 2.
P-2-17	Pier 2, Underside of Cap between Columns 1 and 2	2'-1" wide x 2'-4" long area of delaminated concrete just north of Column 2.
P-2-18	Pier 2, Underside of Cap between Columns 2 and 3	6" wide x 2'-8" long area of delaminated concrete just south of Column 2.
P-2-19	Pier 2, Underside of Cap between Columns 2 and 3	6'-10" wide x 1'-10" long area of delaminated concrete that extends up to 8" high on the east face.
P-2-20	Pier 2, Underside of Cap between Columns 2 and 3	1'-3" wide x 1'-11" long area of delaminated concrete in a patch.
P-2-21	Pier 2, Top of Pedestal 1 at Southwest Corner	9 1/2" wide x 5" long area of delaminated concrete.
P-3-1	Pier 3, East Face of Column 3	1'-10" wide x 9" high area of delaminated concrete in a patch at the bottom.
P-3-2	Pier 3, South Face of Column 2	11" wide x 10" high area of delaminated concrete.
P-3-3	Pier 3, South Face, Pedestal 4	1/8" wide x 6" long diagonal crack.
P-3-4	Pier 3, Underside of Cap, North Overhang	3" wide x 7" long x 1/4" deep spall.
P-4-1	Pier 4, East Face of Cap above Column 2	4'-9" wide x 4" high area of delaminated concrete that extends up to 9" wide on the top face.
P-4-2	Pier 4, East Face of Cap above Column 1	2'-3" wide x 7" high area of delaminated concrete that extends up to 7" wide on the top face with a 1/16" wide perimeter crack.
P-4-3	Pier 4, East Face of Cap, North Overhang	1'-4" wide x 1'-6" high area of delaminated concrete.
P-4-4	Pier 4, East Face of Cap, North Overhang	1'-0" wide x 9" high area of delaminated concrete.
P-4-5	Pier 4, South Face of Pedestal 4	1/16" wide x 1'-7" long horizontal crack.
P-4-6	Pier 4, West Face of Cap, South Overhang	1'-4" wide x 9" high area of delaminated concrete.

BR 1-758H Substructure Repair Defects (Continued)

Defect Number	Location	Description
P-4-7	Pier 4, West Face of Column 1	4" wide x 1'-1" high x 2" deep painted over corner spall.
P-4-8	Pier 4, West Face of Column 2	2'-1" wide x 3'-5" high area of delaminated concrete.
P-4-9	Pier 4, Underside of Cap, North Overhang	2'-4" wide x 4'-6" long area of delaminated concrete.
P-5-1	Pier 5, East Face of Cap, South Overhang	6" wide x 6" long area of delaminated concrete.
P-5-2	Pier 5, East Face of Cap between Columns 1 and 2	1'-3" wide x 5" high area of delaminated concrete in a patch.
P-5-3	Pier 5, East Face of Cap between Columns 1 and 2	9" wide x 1'-1" high area of delaminated concrete.
P-5-4	Pier 5, South Face, Column 1	6" wide x 1'-8" high area of delaminated concrete with minor spalling up to 3/4" deep.
P-5-5	Pier 5, West Face, Column 2	1'-0" wide x 1'-1" high area of delaminated concrete.
P-5-6	Pier 5, West Face of Cap above Column 1	1'-8" wide x 9" high area of delaminated concrete.
P-5-7	Pier 5, West Face of Cap above Column 2	1'-8" wide x 1'-9" high area of delaminated concrete.
P-5-8	Pier 5, Underside of Cap, North Overhang	8" wide x 2'-8" long area of delaminated concrete.
P-5-9	Pier 5, Underside of Cap between Columns 1 and 2	1'-8" wide x 1'-0" long area of delaminated concrete.
P-6-1	Pier 6, East Face of Cap, South Overhang	8" wide x 1'-4" high area of delaminated concrete with a cold joint up to 1/8" wide.
P-6-2	Pier 6, East Face of Cap above Column 2	7'-0" wide x 6" high area of delaminated concrete that extends up to 6" wide on the top face with up to 1/4" wide perimeter cracking. (Note: Utility conduit is attached at delamination)
P-6-3	Pier 6, East Face of Cap between Columns 1 and 2	1'-6" wide x 9" high area of delaminated concrete.
P-6-4	Pier 6, East Face of Cap above Column 1	2'-0" wide x 1'-4" high area of delaminated concrete.
P-6-5	Pier 6, East Face of Cap, North Overhang	2'-6" wide x 6" high area of delaminated concrete with hairline cracking and corrosion stains.

BR 1-758H Substructure Repair Defects (Continued)

Defect Number	Location	Description
P-6-6	Pier 6, West Face, Column 2	9" wide x 16" high area of delaminated concrete.
P-6-7	Pier 6, West Face of Cap above Column 2	Up to 1/16" wide x 1'-0" long horizontal crack with corrosion stains behind utility conduit.
P-6-8	Pier 6, West Face of Cap, South Overhang	Up to 1/16" wide x 1'-2" long horizontal crack behind utility conduit.
P-6-9	Pier 6, Underside of Cap, North Overhang	1'-8" wide x 1'-3" long area of delaminated concrete.
P-6-10	Pier 6, Underside of Cap between Columns 1 and 2	5'-10" wide x 11" long area of delaminated concrete with hairline map cracking within and adjacent to patches.
P-6-11	Pier 6, Underside of Cap between Columns 1 and 2	2'-6" wide x 1'-0" long area of delaminated concrete.
P-6-12	Pier 6, Underside of Cap between Columns 1 and 3	2'-2" wide x 1'-0" long area of delaminated concrete with a 7" diameter x 3/4" deep spall.
P-6-13	Pier 6, Underside of Cap between Columns 1 and 2	9" wide x 5" long area of delaminated concrete.
P-6-14	Pier 6, Underside of Cap, South Overhang	1'-1" wide x 1'-4" long area of delaminated concrete.
P-6-15	Pier 6, Top of Cap, North Overhang	11" wide x 9" long area of delaminated concrete.
P-6-16	Pier 6, Top of Cap above Column 2	3" wide x 4'-3" long area of delaminated concrete that extends 3" high on the west face, with up to 3/16" wide cracking at the chamfer.
P-7-1	Pier 7, East Face of Cap, South Overhang	4'-6" wide x 10" high area of delaminated concrete with a 1/8" wide x 4'-6" long horizontal crack.
P-7-2	Pier 7, East Face of Cap between Columns 1 and 2	1'-7" wide x 1'-6" high area of delaminated concrete.
P-7-3	Pier 7, East Face of Cap between Columns 1 and 2	1'-10" wide x 1'-0" high area of delaminated concrete.
P-7-4	Pier 7, East Face of Cap between Columns 1 and 2	11" wide x 10" high area of delaminated concrete.
P-7-5	Pier 7, East Face of Cap above Column 1	2'-2" wide x 1'-8" high area of delaminated concrete.

BR 1-758H Substructure Repair Defects (Continued)

Defect Number	Location	Description
P-7-6	Pier 7, East Face of Cap between Columns 1 and 2	1/8" wide x 4'-0" long horizontal crack.
P-7-7	Pier 7, East Face of Cap between Columns 1 and 2	9" wide x 1'-0" high area of delaminated concrete.
P-7-8	Pier 7, East Face of Cap between Columns 1 and 3	2'-10" wide x 8" high area of delaminated concrete that extends up to 14" wide on the top face with up to 1/4" wide cracking and minor spalling up to 1" deep.
P-7-9	Pier 7, Top of Cap, North Overhang	2'-8" wide x 2'-1" long area of delaminated concrete.
A-8-1	East Abutment, Northwest Wingwall, at end of Beam Seat	1/16" to 1/8" wide x 2'-1" high vertical crack with heavy efflorescence.
A-8-2	East Abutment, North Face of Pedestal 6	11" long x 2" high area of delaminated concrete that extends up to 2" wide on top of the pedestal.
A-8-3	East Abutment, Front Face, below Bay 1	1/16" wide x 2' long horizontal crack.

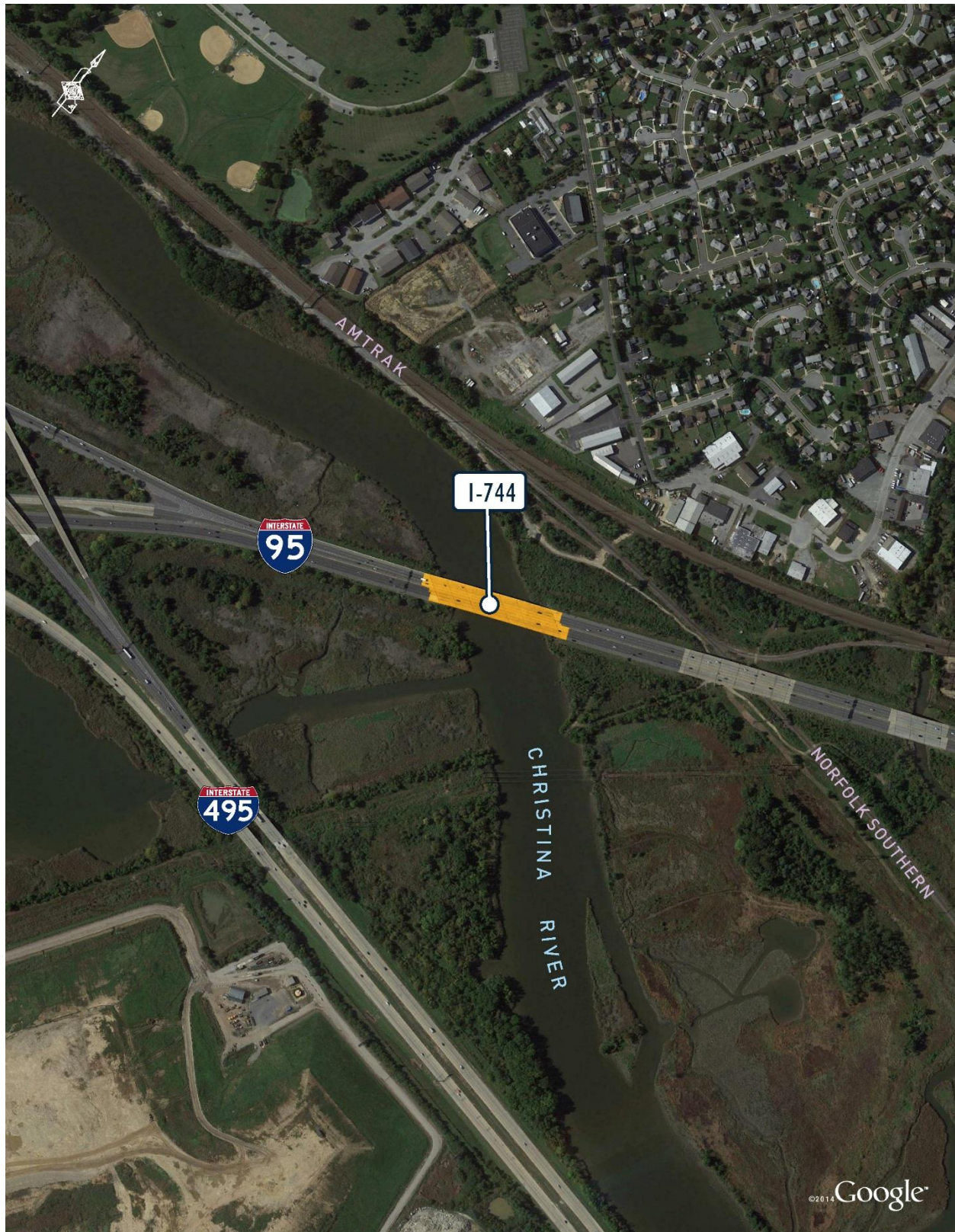
4.9 Bridge 1-744

4.9.1 Bridge Description

Bridge 1-744 is located on I-95 over the Christina River (see Location Map in Section 4.9.2). This structure is a seven (7) span simply supported steel beam bridge built in 1962, widened in 1977, and rehabilitated in 2000. The bridge has an overall length of 558'-6"± measured from centerline of abutment bearings with span lengths of 79'-3"±, 80'-0"±, 80'-0"±, 80'-0"±, 80'-0"±, 80'-0"±, and 79'-3"±. The bridge has an out-to-out width of 111'-1"± providing a clear roadway width of 52'-5"± in each direction. The bridge carries six (6) lanes of traffic on I-95, three (3) lanes each in the northbound and southbound directions. The superstructure consists of sixteen (16) painted steel rolled beams with welded cover plates supporting a 7 1/2"± thick reinforced concrete deck. According to plans, the existing deck is protected with a 2"± thick LMC overlay. Both the median and outside shoulder barriers are 2'-8"± high jersey shape reinforced concrete parapets. The substructure consists of reinforced concrete hammerhead piers and reinforced concrete stub abutments.

Note, the numbering convention used in this report follows the numbering convention used in the biennial inspection reports where the first span is numbered 1. This is the same numbering convention used in the plans.

4.9.2 Location Map



4.9.3 NDE Plan

The bridge deck was surveyed using NDE methods in order to assess the condition of the structural concrete deck. The goal of the NDE program was to determine the structural concrete deck's remaining service life and the proposed approximate quantity of structural concrete deck repairs. The assessment was conducted using IE methodology in order to determine the location and severity of observed debonding between the base structural concrete deck and the LMC overlay, and delaminations within the base structural deck. The left, middle, and right lanes in both the northbound and southbound directions were surveyed in all seven (7) spans (a total of 42 "span-lanes").

4.9.3.1 NDE Results

The following is a summary of the NDE results. Delaminations are defined as predominately horizontal cracks found in the base structural deck, while debonding is defined as a separation or loss of bond between the base structural deck and the LMC overlay. Results are presented with an IE deck condition rating from 0 to 100 (these are relative condition ratings with respect to each project bridge and cannot be compared to any other bridges) and an overall IE deck condition state of Good, Fair, Poor, or Serious, quantified by deck area percentage (%). Good (or "sound") is defined by the lack of delaminations within the base structural deck. Fair is defined as the potential presence of initial delamination described as occasional (local) separations within the deck. Poor is defined as the presence of a continuous delamination of a smaller width, relative to the depth, or thickness, of the deck. In many cases, it cannot be detected by chain drag or hammer sounding as it is often outside the audible range given the delamination is located deeper within the deck between the top and bottom mats of reinforcing steel. Serious is defined as a continuous delamination of a larger width, relative to the depth and is a result of flexural oscillations of the delaminated part of the deck. It is in the audible range. Areas of the deck in serious condition can be detected by chain drag or hammer sounding given the delamination is located at or near the top mat of reinforcing steel. Note that the IE deck condition states do not correlate with the NBI visual condition state ratings of 7, 5, 4, or 3, respectively. For further information and complete results, please reference the full NDE report in Appendices B and C.

This bridge has an overlay thickness varying between 1.5" and 2.63". On average, about 50% of the deck area shows no signs of delamination, about 40% is in a state of incipient delamination, and close to 10% of the deck area is in a state of fully developed delamination. For an overlay of this thickness, it is expected that there is an equal possibility that the serious condition is a result of either debonding of the overlay or delamination of the structural deck. Delamination is generally randomly distributed, with several spans delaminated close to the joints. Overall, the deck is in fair condition.

4.9.4 Concrete Coring Plan

Two (2) 3.25" diameter concrete core samples approximately 7" in length were extracted and laboratory tested in accordance with ASTM C42. Compressive strength testing was performed on the structural layers of the deck only, excluding any portion of the LMC overlay in accordance with ASTM C39. Six (6) cores were tested for compressive strength, two (2) of which were additionally tested for water soluble chloride ions in accordance with ASTM C1218. Two (2) cores were sent to Highbridge Materials Consulting, Inc. for petrographic examination and air-void analysis in accordance with ASTM C856 and ASTM C457, respectively.

4.9.4.1 Concrete Core Results

The following is a summary of the concrete coring results; for further information, please reference the full report in Appendix D.

The design strength of the concrete deck is 3000 psi. The tested cores resulted in an average compressive strength of 4881 psi, with a range of 4280 psi to 5620 psi.

Three (3) depth results in the base structural deck (0.5", 1", and 2") were obtained from the water soluble chloride ion core sample. The top layer of steel is located at 1.5" according to the plans. The chloride content is 0.385 lbs./c.y. at the 0.5" depth, 0.165 lbs./c.y. at the 1" depth, and 0.07 lbs./c.y. at the 2" depth. In accordance with DelDOT's Bridge Design Manual May 2005 Figure 9-1, a level of chloride contamination from 0 to 1.3 is considered low, 1.3 to 2.0 is considered moderate, and greater than 2.0 is considered advanced. Therefore chloride contamination in the upper layer and lower layers is considered low.

4.9.4.2 Petrographic Analysis Results

Cores 744NB-1P and 744SB-1P were sent to Highbridge Materials Consulting, Inc. for petrographic and air voids analysis. The following is a summary of the test results. For further information please reference the "Petrographic Examination Report" prepared by Highbridge Materials Consulting, Inc. dated March 22, 2015, in Appendix E.

The petrographic analysis of the cores indicated that the samples represent a moderate quality mixture suitable for many normal-duty, non-aggressive service environments. The material is a normal weight, Portland cement concrete with no supplementary cementitious materials. The concrete in the cores appears to have proper consolidation and the aggregates and cements appears to be well mixed. No signs of improper workmanship were identified and the water to cement ratios are estimated to be in the mid to high 0.4's. Axial micro-cracking related to early stage ASR was observed throughout one of the cores. However, the reactions observed have not compromised the integrity of the concrete and no imminent threat is suggested by the existing conditions. Carbonation depths are very low and the concrete does not appear to be at any risk of pH-related issues. The concrete core samples have air voids that are typical for industry standards for concrete exposed to freeze thaw.

The total air voids observed in core 744NB-1P was 6.7% and the total air voids observed in core 744SB-1P was 6.4%. Current specifications for concrete exposed to freezing and thawing cycles, per ACI 318 Chapter 4 Section 4, are considered within acceptable limits from 3.5% to 6.5%. The results for core 744NB-1P were found to be within this specification and the results for core 744SB-1P were found to be slightly above.

4.9.5 Paint Adhesion Testing

Paint adhesion testing was performed on pre-selected locations throughout the viaduct on representative areas of distressed or peeling paint, in addition to areas where the coating system was intact. A NACE Level 1 certified inspector performed the test utilizing a portable adhesion tester in accordance with ASTM D4541. At each test location, the inspector documented a description of the failure (paint vs. adhesive), and the tensile strength (psi). Additionally, the inspector determined and recorded the coating thickness, utilizing an electronic dry film thickness gauge per the procedures outlined in SSPC-PA2. The variability of the testing results summarized in Appendix F suggest further testing locations are required. After consultation with the Department, it was agreed the entire superstructure will be repainted.

4.9.6 Summary of Findings

The following is a summary of the visual inspection findings; for further information, please reference the inspection field observation notes in Appendix H.

The deck joints exhibit signs of leakage. The painted steel beams exhibit localized areas of freckled rust and peeling paint mainly at the beam ends with some areas of exposed and rusted steel (see Photo 1). Several bearings have sheared or bent anchor bolts (see Photo 2). The reinforced concrete piers and abutments typically have cracking, spalls, and areas of delaminated concrete (see Photos 3, 4, and 5). There is a cable wrapped around the Pier 2 West column. There is a section of missing riprap exposing a portion of the footing at the south abutment (see Photo 6). There is erosion and adjacent undermining of the concrete slope protection at the north abutment (see Photo 7).

A special Underwater Inspection (UWI) of Bridge 1-744 was performed on January 19 and 20, 2015. The underwater portions of the substructure are in fair condition. The reinforced concrete stems typically exhibit

scaling up to 1-inch deep. Areas of moderate scaling up to 3-inches deep are present at isolated locations with and without exposed steel reinforcement with moderate section loss. The west stem of Pier 5 exhibits up to 6-inch deep scaling with exposed steel reinforcement with up to 90% section loss. The top of the footings are exposed at Piers 2, 4 and 5. Steel sheet piling is present at Piers 1 through 5; the sheet piling typically protrudes up to 3-feet from the mudline.

4.9.6.1 Defect Photographs

The defect photos are representative of the as-inspected condition; additional photos are available upon request.



Photo 1: Typical beam end paint condition (Beam 8, Span 1 at Pier 1 shown)



Photo 2: Typical Sheared Anchor Bolt (Bearing 1 at Pier 5, Span 6 Shown)



Photo 3: Typical Spall (North Face, Pier 5, East Overhang, Center pier)



Photo 4: Typical horizontal 1/16" wide crack (North Abutment stem, Bay 5 shown)



Photo 5: Typical area of delaminated concrete (Pier 6, west pier, south face, Bay 1 shown)



Photo 6: Exposed footing at the South Abutment



Photo 7: Erosion at the North Abutment slope

4.9.7 Defect Tables

BR 1-744 Deck Defects

Defect Number	Location	Description
D-1-1	Span 1, Bay 13 Soffit	1" x 6" x 12" spall with girder showing 1'-4" wide x 1'-2" high.
D-2-1	Span 2, North Face, Bay 12 at Beam 12	7" long x 5" wide x 2" deep spall with exposed corroded reinforcement in the soffit 2'-0" from the end diaphragm
D-4-1	Bay 5 Soffit, Span 4	1'-3" long x 10" wide x 2.5" deep spall with exposed corroded reinforcement adjacent to Beam 6, 2'-0" from the end diaphragm.
D-4-2	Bay 14 Soffit at Bearing 14, Span 4	1'-0" long x 6" wide x 1/2" deep spall.
D-4-3	Span 4, Beam 5	4" wide x 1'-2" long x 2" deep spall 2'-0" from the end diaphragm at the haunch at the east edge of Beam 5.
D-4-4	Span 4, Beam 7	10" x 10" area rusted away SIP forms between the end diaphragms at the east edge of Beam 7.
D-4-5	Bay 11 Soffit at Bearing 11, Span 4	1'-3" x 8" x 2" deep spall in the soffit 1'-0" from the diaphragm.
D-4-6	Bay 11 Soffit at Bearing 12, Span 4	1'-8" wide x 10" long x 2.5" deep spall with exposed corroded reinforcement in the soffit 1'-0" from the diaphragm.
D-5-1	Bay 5 at Beam 6, Span 5 Soffit	Hairline map cracking and hollow sounding patch 14" x 14", 2'-0" from the end diaphragm.
D-5-2	Bay 4, Span 5 Soffit	Random honeycombing up to 1/4" deep in the soffit.
D-6-1	Bay 2, Pier 5, Span 6	3" wide x full length x 1/4" deep edge spalling in soffit along the end diaphragm.
D-6-2	Span 6, Bay 14, Soffit	2'-0" wide x 8" long x 3" deep spall near diaphragm.
D-6-3	Span 6, Bay 15, Soffit	6" wide x 1'-1" long x 2" deep spall with exposed corroded reinforcement in the soffit at the diaphragm.
D-6-4	Span 6, Bay 11, Soffit	1'-3" wide x 5" long x 2" deep spall with exposed corroded reinforcement in soffit 1'-0" from the end diaphragm.

BR 1-744 Superstructure Defects

Defect Number	Location	Description
S-2-1	Bearing 1, Pier 1, Span 2	The west anchor bolt is sheared.
S-2-2	Bearing 2, Pier 1, Span 2	The east anchor bolt is leaning south.
S-2-3	Bearing 3, Pier 1, Span 2	The west anchor bolt is leaning west.
S-2-4	Bearing 4, Pier 1, Span 2	Both anchor bolts are sheared.
S-2-5	Bearing 5, Pier 1, Span 2	Both anchor bolts are sheared.
S-2-6	Bearing 7, Pier 1, Span 2	Bearing 7 is misaligned
S-2-7	Bearing 8, Pier 1, Span 2	The east anchor bolt is leaning west and the west anchor bolt is leaning south.
S-2-8	Bearing 9, Pier 1, Span 2	The east anchor bolt is sheared. The west anchor bolt is leaning south.
S-2-9	Bearing 10, Pier 1, Span 2	The east anchor bolt is sheared. The west anchor bolt is leaning south.
S-2-10	Bearing 11, Pier 1, Span 2	The west anchor bolt is bent to the south.
S-2-11	Bearing 12, Pier 1, Span 2	The west anchor bolt is sheared.
S-2-12	Bearing 13, Pier 1, Span 2	The west anchor bolt is sheared.
S-2-13	Bearing 14, Pier 1, Span 2	The west anchor bolt is sheared and the east anchor bolt is bent south.
S-2-14	Bearing 15, Pier 1, Span 2	The west anchor bolt is sheared and the east anchor bolt is leaning south.
S-2-15	Bearing 16, Pier 1, Span 2	Both anchor bolts are leaning south.
S-3-1	Bearing 7, Pier 3, Span 3	There is only one nut on the west anchor bolt.
S-4-1	Bearing 1, Pier 3, Span 4	East anchor bolt is sheared
S-4-2	Bearing 13, Pier 3, Span 4	The east anchor bolt is leaning south. The west anchor bolt is sheared.
S-4-3	Bearing 14, Pier 3, Span 4	Both anchor bolts are leaning south.
S-4-4	Bearing 15, Pier 3, Span 4	Both anchor bolts are leaning south.
S-4-5	Bearing 16, Pier 3, Span 4	Both anchor bolts are sheared.
S-5-1	Bearing 9, Pier 4, Span 5	1 of 2 anchor bolt nuts on the west side is missing
S-5-2	Beam 14, Pier 5, Span 5	The east anchor bolt is sheared.
S-5-3	Beam 15, Pier 5, Span 5	One anchor bolt is missing.
S-6-1	Bearing 1, Pier 5, Span 6	The east anchor bolt is sheared and the west anchor bolt is loose.
S-6-2	Bearing 3, Pier 5, Span 6	The east anchor bolt is bent south and the west anchor bolt is sheared.
S-6-3	Bearing 4, Pier 5, Span 6	Both anchor bolts are bent south.
S-6-4	Bearing 5, Pier 5, Span 6	Both anchor bolts are bent north.
S-6-5	Bearing 9, Pier 5, Span 6	The east anchor bolt is bent south.
S-6-6	Bearing 11, Pier 5, Span 6	Both anchor bolts are sheared.
S-6-7	Bearing 12, Pier 5, Span 6	The west anchor bolt is sheared.
S-6-8	Bearing 14, Pier 5, Span 6	The east anchor bolt is sheared.
S-6-9	Bearing 15, Pier 5, Span 6	The east anchor bolt is sheared.
S-7-1	Bearing 11, Pier 6, Span 7	The east anchor bolt is bent to the south.

BR 1-744 Superstructure Defects (Continued)

Defect Number	Location	Description
S-7-2	Bearing 12, Pier 6, Span 7	The east anchor bolt is bent to the south.

BR 1-744 Substructure Defects

Defect Number	Location	Description
A-1-1	South Abutment, Top of Backwall, West end	1/16" wide x 1'-8" long diagonal crack.
A-1-2	South Abutment, Bay 10 Backwall	7" x 6" x up to full depth spall with exposed corroded reinforcement.
A-1-3	South Abutment, Bay 15 Backwall	1'-6" wide x 6" high area of delaminated concrete adjacent to Beam 15.
A-1-4	South Abutment, Bay 16 Stem	1'-6" x 2'-0" long area of delaminated concrete on top of the stem.
A-1-5	South Abutment, Below Beams 6-8	The footing is exposed within a riprap repair.
A-1-6	South Abutment, Beam seat	There is a light amount of debris throughout.
A-1-7	Southwest Wingwall	3'-0" wide x 7" high area of delaminated concrete below top of parapet and 9'-0" from the backwall.
A-1-8	Southwest Wingwall	1'-6" wide x 7" high area of delaminated concrete 3'-6" south of Defect A-1-7.
P-1-9	Pier 1, Underside of the East Pier overhang	1'-5" wide x 2'-0" long area of delaminated concrete with a 1'-2" wide x 4" long x 1/2" deep spall with exposed corroded reinforcement.
P-1-10	Pier 1, Underside of the East Pier overhang	1'-8" wide x 1'-3" long area of delaminated concrete.
P-1-11	Pier 1, South face, bottom of West overhang	3'-0" long x 1/16" wide crack.
P-1-12	Pier 1, Bearing 10, Span 1	8" wide x 3" high x 2" deep spall underneath the Southeast corner (no undermining).
P-1-13	Pier 1, North Face, Bay 5	1/4" wide x 6'-0" long horizontal crack 6" below the top of the cap.
P-1-14	Pier 1, North Face, Bay 7	1/8" wide x 3'-0" long vertical crack emanating from the west edge of Bearing 8.
P-1-15	Pier 1, North Face, Below Beam 11	3'-6" wide x 10" high area of delaminated concrete.
P-1-16	Pier 1, North face, Bay 11-12	1/4" wide x 10'-0" long horizontal crack at the bottom of a 10'-0" wide x 6" high area of delaminated concrete.
P-1-17	Pier 1, North Face, West of Pier Column	2'-0" wide x 1'-0" high x 2" deep spall with exposed corroded reinforcement in the west face.
P-1-18	Pier 1, North Face, Bay 14	1'-3" high x 4'-0" long area of delaminated concrete with a 1/4" wide x 4'-0" long horizontal crack.
P-2-1	Pier 2, West Pier Column	Cable wrapped around the shaft 2'-0" above the high water line.
P-2-2	Pier 2, Bay 1	1'-2" wide x 1'-5" high area of delaminated concrete at the step.
P-2-3	Pier 2, Center Pier Column, South Face	2" wide x 4" high x 1/4" deep spall with exposed corroded reinforcement 1'-0" above the high water line.
P-2-4	Pier 2, Bay 12, South Face	2'-0" wide x 1'-8" high area of delaminated concrete below a patch.

BR 1-744 Substructure Defects (Continued)

Defect Number	Location	Description
P-2-5	Pier 2, Under Beam 16, South face	1/16" wide x 4'-0" long horizontal crack.
P-2-6	Pier 2, East face of the East Pier	2'-0" wide x 2'-6" high delaminated patch in the bottom at the south edge.
P-2-7	Pier 2, Under Beam 4, North Face	1/8" wide x 3'-0" long horizontal crack.
P-2-8	Pier 2, Center Pier Column, North Face	4" wide x 4" high x 1/2" deep spall with exposed corroded reinforcement above the high water line.
P-2-9	Pier 2, East Pier, North Face, approx. 2'-0" under Bay 13	1'-2" wide x 2'-0" high area of delaminated concrete.
P-2-10	Pier 2, East Pier, North Face, under Beam 13	1'-2" wide x 1'-0" high area of delaminated concrete.
P-2-11	Pier 2, East Pier, North Face, approx. 6" under Bay 13	1'-6" wide x 1'-2" high area of delaminated concrete.
P-2-12	Pier 2, East Pier, North Face, under Beam 14	3'-6" wide x 10" high area of delaminated concrete.
P-2-13	Pier 2, East Pier, North Face, approx. 1'-0" under Bay 14	2'-0" wide x 1'-3" high area of delaminated concrete in a patch.
P-3-1	Pier 3, South Face, approx. 6" under Beam 2	1/4" wide x 6'-0" long horizontal crack.
P-3-2	Pier 3, South Face, Bay 2	1'-6" high x 3'-0" wide area of delaminated concrete
P-3-3	Pier 3, South Face, under Beam 3	1/16" wide x 4'-0" long horizontal crack.
P-3-4	Pier 3, South Face, Bay 3	2'-6" wide x 1'-0" high area of delaminated concrete with a 2'-6" long horizontal crack.
P-3-5	Pier 3, South Face, Bay 4	5'-6" wide x up to 1'-3" high area of delaminated concrete.
P-3-6	Pier 3, South Face, Bay 6	1/8" wide x 4'-0" long horizontal crack.
P-3-7	Pier 3, South Face, approx. 10" under Beam 5	2'-6" wide x 1'-8" high area of delaminated concrete.
P-3-8	Pier 3, South face, West Pier, Column	1'-6" wide x 1'-3" high area of delaminated concrete with a 8" wide x 4" high x 1/2" deep spall.
P-3-9	Pier 3, South Face, Center Pier, under Beam 8	3'-0" wide x 1'-3" high area of delaminated concrete.
P-3-10	Pier 3, South Face, Center Pier, West side of Column	1'-10" wide x 1'-0" high area of delaminated concrete.
P-3-11	Pier 3, South Face, Center Pier, under Beam 9	1'-6" wide x 1'-6" high area of delaminated concrete.
P-3-12	Pier 3, South Face, East Pier, Bay 11	1/8" wide x 4'-0" long horizontal crack.
P-3-13	Pier 3, South Face, East Pier, Bay 12	2'-0" wide x 2'-0" high area of delaminated concrete with a 5" wide x 6" high x 1/2" deep spall.
P-3-14	Pier 3, South Face, East Pier, Bay 12	1/8" wide x 4'-0" long horizontal crack.
P-3-15	Pier 3, South Face, center of East Pier.	1'-6" wide x 2'-6" high area of delaminated concrete within a patch.
P-3-16	Pier 3, South Face, East Pier, under Beam 14	1'-2" wide x 3'-6" high area of delaminated concrete.

BR 1-744 Substructure Defects (Continued)

Defect Number	Location	Description
P-3-17	Pier 3, South Face, East Pier, under Beam 16	1'-6" wide x 1'-6" high area of delaminated concrete adjacent to a patched area.
P-3-18	Pier 3, North Face, West Pier, Bay 1	1/8" wide x 5'-0" long horizontal crack.
P-3-19	Pier 3, North Face, West Pier, Bay 1	1'-8" wide x 10" high area of delaminated concrete.
P-3-20	Pier 3, North Face, West Pier, Bay 3	3'-0" wide x 1'-6" high area of delaminated concrete extending from a delamination in the beam seat.
P-3-21	Pier 3, West Pier, Bay 3 Beam Seat	5" wide x 3'-0" long area of delaminated concrete with a 1/4" wide x 3'-0" long crack adjacent to Bearing 4
P-3-22	Pier 3, North Face, West Pier, Bay 4	1/4" wide x 3'-6" long horizontal crack with small edge spalls.
P-3-23	Pier 3, North Face, Center Pier, Bay 8	6" wide x 1'-6" high area of delaminated concrete adjacent to a full cap height previously sealed crack.
P-3-24	Pier 3, West Side, North Face, Center Pier column	11" wide x 2'-4" high area of delaminated concrete in the corner chamfer 2'-0" above the high water line along a previously sealed crack.
P-3-25	Pier 3, North Face, East Pier, Bay 12	4'-0" wide x 1'-4" high area of delaminated concrete along a previously sealed crack.
P-3-26	Pier 3, North Face, East Pier, under Bearing 16	1'-6" x 1'-0" area of delaminated concrete with a 1/16" wide horizontal crack at the bottom.
P-3-27	Pier 3, North Face, East Pier, under Bearing 16	Up to 1/8" wide x full height vertical crack.
P-4-1	Pier 4, South Face, West Pier, Bay 4	1/8" wide x 3'-0" long horizontal crack.
P-4-2	Pier 4, South Face, West Pier, under Beam 4	2'-0" x 2'-0" x 1/8" deep scaling.
P-4-3	Pier 4, South Face, Center Pier, under Bay 7	1/16" wide x 2'-0" long horizontal crack.
P-4-4	Pier 4, South Face, Center Pier, under Beam 8	1/8" wide x 3'-6" long vertical crack.
P-4-5	Pier 4, South Face, Center Pier, under Beam 8	1/8" wide x 10" long horizontal crack.
P-4-6	Pier 4, South Face, Center Pier, under Bay 8	2'-0" wide x 3'-0" high area of delaminated concrete.
P-4-7	Pier 4, South Face, Center Pier, under Beam 9	Failing patch with 2'-6" wide x 1'-8" high area of delaminated concrete adjacent to a 10" wide x 5" high x 2" deep spall.
P-4-8	Pier 4, South Face, Center Pier, under Beam 9	1/16" wide x 2'-8" long vertical crack with efflorescence.
P-4-9	Pier 4, South face, Center Pier, West side of column	10" wide x up to 2'-0" high area of delaminated concrete in the corner chamfer between patches 12' above the high water line
P-4-10	Pier 4, South face, East Pier, Bay 12	5" wide x 6" high x 1/2" deep spall with exposed corroded reinforcement within a patch.
P-4-11	Pier 4, South face, East Pier, under Beam 14	1" wide x 1'-0" high x 1/4" deep spall with exposed corroded reinforcement within a patch.

BR 1-744 Substructure Defects (Continued)

Defect Number	Location	Description
P-4-12	Pier 4, South face, East Pier, under Bay 14	4" wide x 5" high x 1/2" deep spall.
P-4-13	Pier 4, West Pier, West face	1/16" wide full height vertical crack located 15" from the North face.
P-4-14	Pier 4, North Face, West Pier, Bay 2	7" wide x 1'-8" high x 1/2" deep spall with exposed corroded reinforcement.
P-4-15	Pier 4, North Face, West pier, Bay 2	1'-2" wide x 11" high delaminated patch.
P-4-16	Pier 4, North Face, Center Pier, West overhang	1/8" wide x 2'-0" long horizontal crack.
P-4-17	Pier 4, North Face, Center Pier, West overhang	1/8" wide x 1'-2" long vertical crack.
P-4-18	Pier 4, North Face, Center Pier, West overhang underside	10" x 10" x 1.25" deep spall.
P-4-19	Pier 4, North Face, Center Pier, under Beam 9	5'-0" high x up to 3'-0" wide area of delaminated concrete that extends 10" into the beam seat and contains a 1'-6" wide x 4" high x 6" deep spall at the edge.
P-4-20	Pier 4, North Face, Center Pier, center	4'-0" wide full height area of water/salt staining.
P-4-21	Pier 4, Bay 14, Span 5	1/16" wide x 4'-0" long vertical crack that emanates from the east side of Bearing 14.
P-4-22	Pier 4, East face, East Pier	1/8" wide x full height vertical crack emanating from Bearing 16.
P-5-1	Pier 5, South face, West Pier, Bay 1	2'-6" wide x 2'-0" high area of delaminated concrete within a patch.
P-5-2	Pier 5, South face, West Pier, under Beam 2	1'-3" high x 1'-6" wide delaminated patch.
P-5-3	Pier 5, South face, West Pier, Bay 4	3'-0" wide x 1'-3" high area of delaminated concrete.
P-5-4	Pier 5, South face, West Pier, Bay 4	3/8" wide x 5'-0" long horizontal crack.
P-5-5	Pier 5, South face, West Pier, Bay 5	2'-0" wide x 2'-6" high area of delaminated concrete.
P-5-6	Pier 5, South face, Center Pier, under Beam 8	1/8" wide x 3'-0" long diagonal crack starting at the west side of Pedestal 8.
P-5-7	Pier 5, South face, Center Pier, under Beam 8	2'-6" wide x up to 2'-4" high area of delaminated concrete with a 2'-0" wide x 5" high x 1" deep spall.
P-5-8	Pier 5, South face, Center Pier, under Beam 9	4'-6" wide x up to 3'-0" high area of delaminated concrete with a 6" wide x 1'-0" high x 1/2" deep spall.
P-5-9	Pier 5, South face, Center Pier, Bay 9	2'-6" wide x 3'-0" area of delaminated concrete.
P-5-10	Pier 5, South face, East Pier, Bay 12	2'-4" wide x 1'-4" high area of delaminated concrete.
P-5-11	Pier 5, South face, East pier, Bay 13	Cracking within a 4'-0" wide x 1'-0" high repair.
P-5-12	Pier 5, South face, East pier, under Beam 15	3'-6" wide x 1'-2" high area of delaminated concrete with cracking.
P-5-13	Pier 5, South face, East pier, under Beam 15	Cracking in the top of a patch.

BR 1-744 Substructure Defects (Continued)

Defect Number	Location	Description
P-5-14	Pier 5, South face, East Pier, East overhang at column	There is an old patch that is cracked and delaminated.
P-5-15	Pier 5, North face, West Pier, Northwest corner	6" x 6" corner spall.
P-5-16	Pier 5, North face, West Pier, Bay 1	3'-0" wide x 2'-6" high area of delaminated concrete adjacent to a 2'-2" wide x 3'-8" high area of delaminated concrete.
P-5-17	Pier 5, North face, West Pier, Bay 1	5'-10" long x 1/8" wide horizontal crack.
P-5-18	Pier 5, North face, West Pier, under Beam 4	2'-0" wide x 1'-4" high area of delaminated concrete.
P-5-19	Pier 5, North face, West Pier, Bay 4	8'-0" long x 1/8" wide horizontal crack.
P-5-20	Pier 5, North face, West Pier, Bay 5	5'-0" long x 1/8" wide horizontal crack.
P-5-21	Pier 5, North face, West Pier, Bay 5	4'-0" wide x 2'-0" area of delaminated concrete.
P-5-22	Pier 5, North face, West Pier, West edge of column	3'-6" long x up to 1/8" wide vertical crack.
P-5-23	Pier 5, North face, West Pier, column	1'-8" wide x 1'-4" high delaminated patch.
P-5-24	Pier 5, North face, Center Pier, Bay 7	6" wide x 1'-6" high x 1/2" deep spall.
P-5-25	Pier 5, North face, Center Pier, Bay 7	3'-0" wide x 1'-6" high area of delaminated concrete.
P-5-26	Pier 5, North face, Center Pier, under Beam 8	8'-0" long x 1/8" wide horizontal crack.
P-5-27	Pier 5, North face, Center Pier, West side of column	7" wide x 1'-0" high x 2" deep spall.
P-5-28	Pier 5, North face, Center Pier, West side of column	2'-6" high x 1'-2" wide area of delaminated concrete with cracking and small spalls.
P-5-29	Pier 5, North face, Center Pier, Bay 8	6'-0" wide x 3'-0" high area of delaminated concrete with 1/8" wide map cracking with a 1'-2" wide x 1'-2" high x 1/2" deep spall.
P-5-30	Pier 5, North face, Center Pier, under Beam 10	10" long x 1/16" wide vertical crack that emanates from the corner of the masonry plate and extends 1'-4" long x 1/16" wide diagonal crack.
P-5-31	Pier 5, North face, Center Pier, East overhang	10" wide x 1'-3" high area of delaminated concrete surrounding a 4" wide x 10" high x up to 3/4" deep spall with exposed corroded reinforcement.
P-5-32	Pier 5, East Pier, West overhang underside	4'-0" long x up to 1/4" wide crack with small edge spalls.
P-5-33	Pier 5, North Face, East Pier, Bay 11	1'-8" wide x 7" high area of delaminated concrete 3" from the top.
P-5-34	Pier 5, Top of cap, East Pier, Bay 12	1/8" wide transverse crack.
P-5-35	Pier 5, North face, East Pier, Bay 13	2'-0" wide x 6" high area of delaminated concrete in patch with 1/8" wide cracking.
P-5-36	Pier 5, North face, East Pier, East overhang at column	6'-0" long x 3/8" wide horizontal crack within a patch.

BR 1-744 Substructure Defects (Continued)

Defect Number	Location	Description
P-5-37	Pier 5, North face, East Pier, under Beam 15	8'-0" long x up to 1/4" wide horizontal crack.
P-5-38	Pier 5, North face, East Pier, Bay 15	6" diameter x 1/2" deep spall.
P-5-39	Pier 5, North face, East end of cap	2'-4" wide x 1'-8" high area of delaminated concrete with hairline map cracks.
P-5-40	Pier 5, North face, East Pier, East side of column	4'-0" long x 3/8" wide vertical crack adjacent to rust stains.
P-5-41	Pier 5, North face, East Pier, East side of column	4'-0" long x 1/8" wide vertical crack.
P-6-1	Pier 6, South face, West Pier, Bay 1	2'-2" long x up to 1'-0" high area of delaminated concrete with cracking up to 1/8" wide in patch.
P-6-2	Pier 6, South face, West Pier, Bay 2	2'-6" wide x 2'-6" high area of delaminated concrete.
P-6-3	Pier 6, South face, West Pier, Bay 3	Hairline cracking in a 7'-6" long x up to 2'-0" high repair patch.
P-6-4	Pier 6, South face, West Pier, Bay 3	4'-0" wide x 1'-8" high area of delaminated concrete with hairline cracking throughout and continues up to 16" on top of cap.
P-6-5	Pier 6, South face, West Pier, Bay 4	2'-4" high x 1'-8" wide area of delaminated concrete with a previously sealed crack with edge spalling.
P-6-6	Pier 6, West Pier, East overhang underside	2'-6" wide x 4'-0" long area of delaminated concrete with two hairline to 1/8" wide cracks through all 4'-0".
P-6-7	Pier 6, South face, Center Pier, under Beam 8	3'-0" wide x 2'-0" high area of delaminated concrete with an associated 1'-0" x 5" x 1/2" deep spall with efflorescence.
P-6-8	Pier 6, South face, Center Pier, Bay 8	2'-0" wide x 2'-6" high area of delaminated concrete surrounding a 2'-1" high vertical hairline crack.
P-6-9	Pier 6, South face, Center Pier, under Beam 9	8" wide x 1'-6" high area of delaminated concrete with a hairline vertical crack.
P-6-10	Pier 6, South face, East Pier, Bay 11	2'-6" wide x 2'-2" high area of delaminated concrete with hairline map cracks along a patch.
P-6-11	Pier 6, South face, East Pier, under Beam 12	1'-4" wide x 3'-6" high area of delaminated concrete with hairline map cracks along a patch.
P-6-12	Pier 6, South face, East Pier, Bay 12	1'-8" wide x 1'-9" high area of delaminated concrete.
P-6-13	Pier 6, East Pier, West overhang underside	6" x 6" x 1/2" deep spall with exposed corroded reinforcement.
P-6-14	Pier 6, South face, East Pier, Bay 14	3'-0" wide x 10" high area of delaminated concrete with a 1/8" wide x 3'-0" long horizontal crack.
P-6-15	Pier 6, South face, East Pier, East side of column	There is a concrete patch along chamfered corner with hairline transverse cracks. The top 1'-4" high x 9" wide is delaminated and extends 1'-6" wide x 2'-6" high in the east face.
P-6-16	Pier 6, East Pier, East overhang underside	2'-6" long x 10" wide x 1/2" deep spall.
P-6-17	Pier 6, East Pier, East overhang underside	6" wide x 9" long x 1/2" deep spall with exposed corroded reinforcement.

BR 1-744 Substructure Defects (Continued)

Defect Number	Location	Description
P-6-18	Pier 6, North face, West Pier, Bay 2	3'-0" wide x 2'-0" high delaminated concrete patch.
P-6-19	Pier 6, North face, West Pier, Bay 3 near Bearing 4	6" high x 1'-8" long area of delaminated concrete extends 1'-8" wide x up to 1'-3" wide in the top of the cap.
P-6-20	Pier 6, North face, West Pier, Bay 3	4'-0" long x 1/8" wide horizontal crack 6" below the cap.
P-6-21	Pier 6, North face, West Pier, Bay 3	1/16" wide x 3'-6" long vertical crack extending 1'-2" into the top of the cap.
P-6-22	Pier 6, North face, West Pier, Bay 4	2'-6" x 1'-8" area of delaminated concrete with spall and hairline cracks.
P-6-23	Pier 6, North face, Center Pier, under Beam 7	2'-6" x 2'-0" area of delaminated concrete.
P-6-24	Pier 6, North face, Center Pier, under Beam 8	3'-0" x 3'-0" area of delaminated concrete with a 1'-0" diameter x 1/2" deep spall with rust staining.
P-6-25	Pier 6, North face, Center Pier, under Beam 8	1'-8" wide x 3'-0" high area of delaminated concrete.
P-6-26	Pier 6, North face, Center Pier, top of column	1'-10" wide x 1'-6" high area of delaminated concrete.
P-6-27	Pier 6, North face, Center Pier, bottom of column	3'-4" wide x 1'-3" high x 2" deep spall at groundline.
P-6-28	Pier 6, East Pier, West overhang underside	1'-0" x 1'-0" x 1/2" deep spall 1'-0" from the north end.
P-6-29	Pier 6, North face, East Pier, Bay 13	2'-0" wide x 6" high area of delaminated concrete with a 1/16" wide crack running thru it.
P-6-30	Pier 6, North face, East Pier, Bay 13, top of cap	1'-0" x 1'-0" area of delaminated concrete in top of cap.
P-6-31	Pier 6, North face, East Pier, under Beam 14	6'-0" long x 1/8" wide horizontal crack.
P-6-32	Pier 6, North face, East Pier, Bay 14	2'-6" long previously sealed crack with a 1'-6" wide x 1'-0" high area of delaminated concrete below it. Above the crack, 2'-6" wide x 4" high delamination that extends 6" into the top of the cap.
A-7-1	North Abutment, Bay 1 Stem	1/16" wide x 1'-0" long horizontal crack.
A-7-2	North Abutment, Bay 1 Stem	1'-0" wide x 1'-2" high area of delaminated concrete adjacent to a 10" wide x 8" high area of delaminated concrete.
A-7-3	North Abutment, Bay 4 Backwall near Beam 5	1'-0" wide x 8" high x 1" deep honeycomb.
A-7-4	North Abutment, Bay 5 Stem	Hairline to 1/16" wide x 5'-6" long horizontal crack with rust stains.
A-7-5	North Abutment, Bay 5 Stem near Beam 6	3'-10" wide x 1'-3" high area of delaminated concrete adjacent to a 8" x 8" area of delaminated concrete.
A-7-6	North Abutment, Bay 6 Backwall near Beam 7	1'-0" wide x 8" high x 1" deep honeycomb.

BR 1-744 Substructure Defects (Continued)

Defect Number	Location	Description
A-7-7	North Abutment, Bay 7 Stem	1'-3" wide x 1'-0" high x 1" deep spall with exposed corroded reinforcement below a 6" wide x 6" high area of delaminated concrete.
A-7-8	North Abutment, Bay 7 Backwall near Beam 8	1'-0" wide x 8" high x 1" deep honeycomb.
A-7-9	North Abutment, Bay 11 Backwall	50% of backwall is honeycombed up to 1" deep.
A-7-10	North Abutment, Bay 11 Backwall near Beam 12	1'-0" wide x 6" high x 2" deep spall behind bearing.
A-7-11	North Abutment, Bay 12 Backwall	2'-6" wide x 1'-0" high area of delaminated concrete.
A-7-12	North Abutment, Bay 13 Backwall	1'-0" x 1'-0" area of delaminated concrete with incipient spalls.
A-7-13	North Abutment, Bay 14 Backwall	1'-0" x 1'-0" area of delaminated concrete.
A-7-14	North Abutment, Bay 14 Backwall	4" x 4" area of delaminated concrete.
A-7-15	North Abutment Slope	2'-0" wide x 1'-0" high x 6'-0" long area of erosion at the west end of the slope; the adjacent flume is undermined 4'-0" long x 8" high x up to 1'-0" penetration.
A-7-16	North Abutment, Beam seat	There is debris on the beam seat in Bays 4, 5, 6, 8, 10, 12, 13, 14, and 15
A-7-17	Northwest Wingwall, Near groundline	1'-4" wide x 8" high area of delaminated concrete.
A-7-18	Northwest Wingwall	1'-8" wide x 1'-1" high area of delaminated concrete.
A-7-19	Northwest Wingwall, near the top	4'-6" wide x 1'-6" high area of delaminated concrete with hairline map cracks and light efflorescence.
A-7-20	Northwest Wingwall Parapet at wingwall/backwall interface	2'-0" wide x 1'-0" high hollow sounding patch with hairline map cracking.
A-7-21	Northwest Wingwall Parapet/wingwall interface	1/16" wide crack along cold joint.

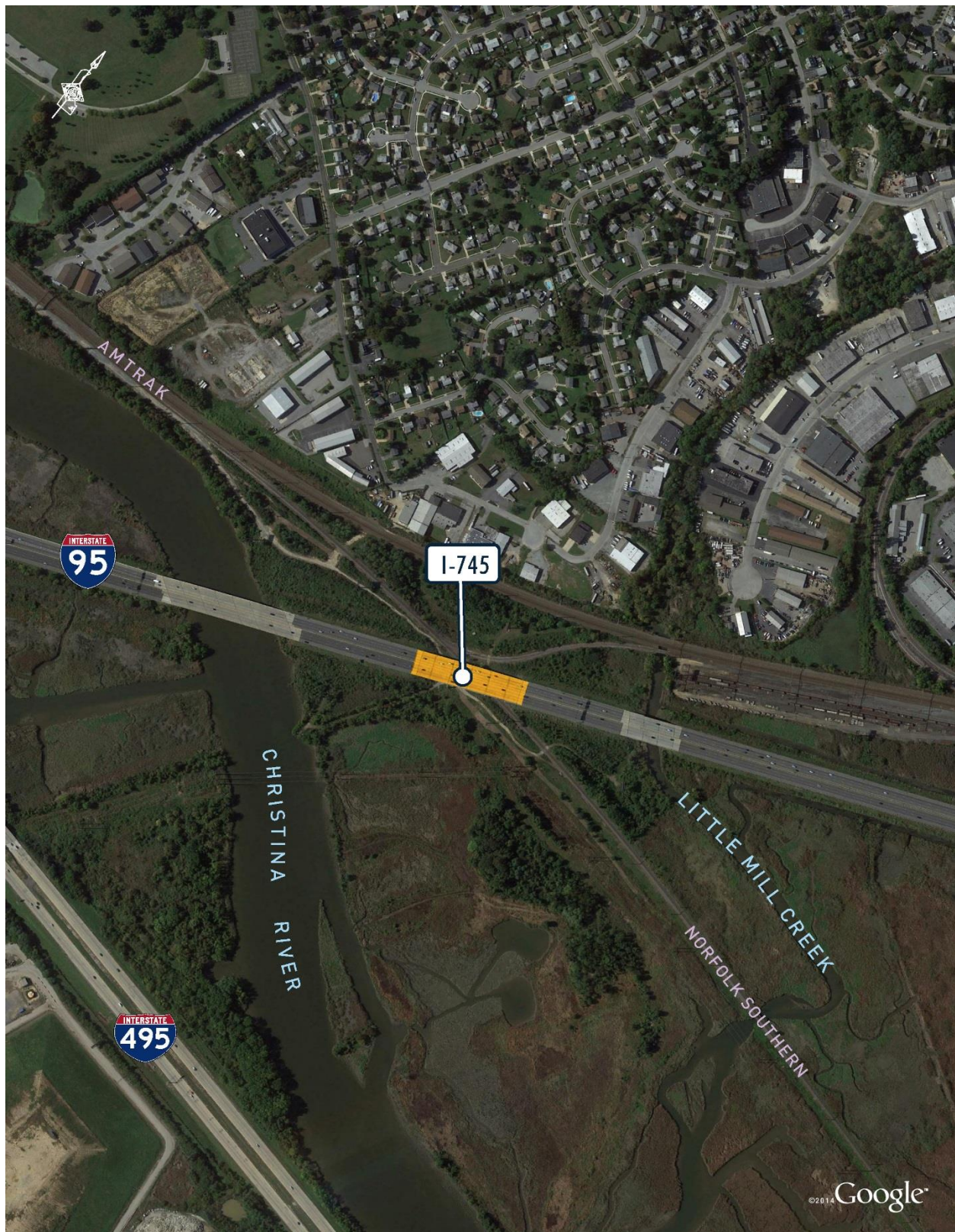
4.10 Bridge 1-745

4.10.1 Bridge Description

Bridge 1-745 is located on I-95 over Norfolk Southern Railroad (see Location Map in Section 4.10.2). This structure is a six (6) span simply supported steel beam bridge built in 1962, widened in 1977, and rehabilitated in 2000. The bridge has an overall length of 460'-0" \pm measured from centerline of abutment bearings with span lengths of 60'-0" \pm , 85'-0" \pm , 85'-0" \pm , 85'-0" \pm , 85'-0" \pm , and 60'-0" \pm . The bridge has an out-to-out width of 111'-1" \pm providing a clear roadway width of 52'-5" \pm in each direction. The bridge carries six (6) lanes of traffic on I-95, three (3) lanes each in the northbound and southbound directions. The superstructure consists of sixteen (16) painted steel rolled beams with welded cover plates supporting a 7½" \pm thick reinforced concrete deck. According to plans, the existing deck is protected with a 2" \pm thick LMC overlay. Both the median and outside shoulder barriers are 2'-8" \pm high jersey shape reinforced concrete parapets. The substructure consists of reinforced concrete pier columns supporting painted steel box girder pier caps and reinforced concrete stub abutments. Confined space entry is required to complete the inspection of the steel box girder pier caps.

Note, the numbering convention used in this report follows the numbering convention used in the biennial inspection reports where the first span is numbered 1. This is the same numbering convention used in the plans.

4.10.2 Location Map



4.10.3 NDE Plan

The bridge deck was surveyed using NDE methods in order to assess the condition of the structural concrete deck. The goal of the NDE program was to determine the structural concrete deck's remaining service life and the proposed approximate quantity of structural concrete deck repairs. The assessment was conducted using IE methodology in order to determine the location and severity of observed debonding between the base structural concrete deck and the LMC overlay, and delaminations within the base structural deck. The left, middle, and right lanes in both the northbound and southbound directions were surveyed in all six (6) spans (a total of 36 "span-lanes").

4.10.3.1 NDE Results

The following is a summary of the NDE results. Delaminations are defined as predominately horizontal cracks found in the base structural deck, while debonding is defined as a separation or loss of bond between the base structural deck and the LMC overlay. Results are presented with an IE deck condition rating from 0 to 100 (these are relative condition ratings with respect to each project bridge and cannot be compared to any other bridges) and an overall IE deck condition state of Good, Fair, Poor, or Serious, quantified by deck area percentage (%). Good (or "sound") is defined by the lack of delaminations within the base structural deck. Fair is defined as the potential presence of initial delamination described as occasional (local) separations within the deck. Poor is defined as the presence of a continuous delamination of a smaller width, relative to the depth, or thickness, of the deck. In many cases, it cannot be detected by chain drag or hammer sounding as it is often outside the audible range given the delamination is located deeper within the deck between the top and bottom mats of reinforcing steel. Serious is defined as a continuous delamination of a larger width, relative to the depth and is a result of flexural oscillations of the delaminated part of the deck. It is in the audible range. Areas of the deck in serious condition can be detected by chain drag or hammer sounding given the delamination is located at or near the top mat of reinforcing steel. Note that the IE deck condition states do not correlate with the NBI visual condition state ratings of 7, 5, 4, or 3, respectively. For further information and complete results, please reference the full NDE report in Appendices B and C.

This bridge has an overlay thickness varying between 0" and 3.25". On average, about 30% of the deck area shows no signs of delamination, about 55% is in the state of incipient delamination, and close to 15% of the deck area is in the state of fully developed delamination. For an overlay of this thickness, it is expected that the serious condition represents debonding of the overlay. However, it is possible that the debonding is underlain by delamination. The southbound bridge deck is slightly more deteriorated than the northbound lanes, especially in the right lane. The last three (3) spans of those two (2) lanes have from 24% to 46% of the deck area fully delaminated. Overall, the deck is in fair condition.

4.10.4 Concrete Coring Plan

A total of eight (8) 3.25" diameter concrete core samples approximately 7" in length were extracted and laboratory tested in accordance with ASTM C42. Compressive strength testing was performed on the structural layers of the deck only, excluding any portion of the LMC overlay in accordance with ASTM C39. Six (6) cores were tested for compressive strength, two (2) of which were additionally tested for water soluble chloride ions. Two (2) cores were sent to Highbridge Materials Consulting, Inc. for petrographic examination and air-void analysis in accordance with ASTM C856 and ASTM C457, respectively.

4.10.4.1 Concrete Core Results

The following is a summary of the concrete coring results; for further information, please reference the full report in Appendix D.

The design strength of the concrete deck is 3000 psi. The tested cores resulted in an average compressive strength of 4815 psi, with a range of 3440 psi to 7120 psi.

Three (3) depth results in the base structural deck (0.5", 1", and 2") were obtained from the water soluble chloride ion core sample. The top layer of steel is located at 1.5" according to the plans. The chloride content is 0.49 lbs./c.y. at the 0.5" depth, 0.31 lbs./c.y. at the 1" depth, and 0.015 lbs./c.y. at the 2" depth. In accordance with DelDOT's Bridge Design Manual May 2005 Figure 9-1, a level of chloride contamination from 0 to 1.3 is considered low, 1.3 to 2.0 is considered moderate, and greater than 2.0 is considered advanced. Therefore chloride contamination in the upper and lower layers is considered low.

4.10.4.2 Petrographic Analysis Results

Cores 745NB-1P and 745SB-1P were sent to Highbridge Materials Consulting, Inc. for petrographic and air voids analysis. The following is a summary of the test results. For further information please reference the "Petrographic Examination Report" prepared by Highbridge Materials Consulting, Inc. dated March 22, 2015, in Appendix E.

The petrographic analysis of the cores indicated that the concrete in each of the core samples represents a moderate quality mixture suitable for many normal-duty, non-aggressive service environments. The material is a normal weight, Portland cement concrete with no supplementary cementitious materials. The concrete in the cores appears to have proper consolidation and the aggregates and cements appears to be well mixed. No signs of improper workmanship were identified and the water to cement ratios are estimated to be in the mid to high 0.4's. Axial micro-cracking related to early stage ASR was observed throughout one of the cores. However, the reactions observed have not compromised the integrity of the concrete and no imminent threat is suggested by the existing conditions. Carbonation depths are very low and the concrete does not appear to be at any risk of pH-related issues. The concrete core samples have air voids that are typical for industry standards for concrete exposed to freeze thaw.

The total air voids observed in core 745NB-1P was 3.5% and the total air voids observed in core 745SB-1P was 4.0%. Current specifications for concrete exposed to freezing and thawing cycles, per ACI 318 Chapter 4 Section 4, are considered within acceptable limits from 3.5% to 6.5%. The results for these cores were found to be within this specification.

4.10.5 Paint Adhesion Testing

Paint adhesion testing was performed on pre-selected locations throughout the viaduct on representative areas of distressed or peeling paint, in addition to areas where the coating system was intact. A NACE Level 1 certified inspector performed the test utilizing a portable adhesion tester in accordance with ASTM D4541. At each test location, the inspector documented a description of the failure (paint vs. adhesive), and the tensile strength (psi). Additionally, the inspector determined and recorded the coating thickness, utilizing an electronic dry film thickness gauge per the procedures outlined in SSPC-PA2. The variability of the testing results summarized in Appendix F suggest further testing locations are required. After consultation with the Department, it was agreed the entire superstructure will be repainted.

4.10.6 Summary of Findings

The following is a summary of the visual inspection findings; for further information, please reference the inspection field observation notes in Appendix H.

The deck joints exhibit signs of leakage. The painted steel beams exhibit areas of exposed and rusted steel throughout. The painted steel pier caps exhibit areas of exposed and rusted steel with section loss at random locations (see Photos 1 - 4). There are several missing and loose bolts in the diaphragms (see Photos 5 and 12). Several of the access grates to the inside of the pier caps are broken or unable to be opened (see Photo 6). Several bearings have sheared or broken anchor bolts (see Photo 8). The reinforced concrete pier columns typically exhibit cracking, spalls, and areas of delaminated concrete (see Photo 9). There are areas of erosion at both abutments (see Photos 10 and 11).

4.10.6.1 Defect Photographs

The defect photos are representative of the as-inspected condition; additional photos are available upon request.



Photo 1: Section loss in the bottom of the stiffener, Pier 2 Cap, South Face, Between Beams 8 and 9



Photo 2: Bent stiffener at Pier 4, Span 4, Bearing 2 Seat



Photo 3: Typical heavy rust and delamination of the pier caps (Pier 4, Span 4 shown)



Photo 4: Typical peeling paint inside the pier caps (Pier 1 Cap, Bay 10 shown)



Photo 5: Missing bolt on the east side of the west full height diaphragm, Pier 3 Cap, Bay 9



Photo 6: Typical broken access grate (Pier 4 Cap, West Overhang shown)



Photo 7: Disconnected and clogged drain pipe (Pier 4, Column 1 shown)



Photo 8: Sheared anchor bolt (Bearing 14, Pier 4 East side shown)



Photo 8: Typical spall at column (Pier 4, Column 1, South Face shown)



Photo 9: South Abutment Slope Erosion



Photo 10: North Abutment Slope Erosion, East end



Photo 11: Missing vertical weld, Pier 4 Cap, Bay 13



Photo 12: Two (2) loose bolts, East full height diaphragm, Pier 1 Cap, Bay 10

4.10.7 Defect Tables

BR 1-745 Superstructure Defects

Defect Number	Location	Defect Description
S-2-1	Beam 16, Pier 2, Span 2, west stiffener for seat	5" wide x 4" high area of section loss at bottom of stiffener.
S-4-1	Bearing 2 Seat, Pier 4, Span 4	The second stiffener from the west edge of the seat is bent at the top, 10" high x 5/8" eastward bend.
S-4-2	Beam 6, East stiffener, Pier 4 North Face, Span 4	East stiffener buckled 1/4" over the bottom 6".
S-4-3	Beam 8, West stiffener, Pier 4, Span 4	West stiffener buckled 3/8" over the top 7".
S-4-4	Bearing 8, Pier 4, Span 4	Anchor bolts are not fully threaded.
S-4-5	Bearing 11, Pier 4, Span 4	Broken anchor bolt on the east side.
S-4-6	Bearing 14, Pier 4, Span 4	Sheared anchor bolt on the east side.
S-5-1	Pier 4, Span 5, Bearing 13	Missing bolt on the west side.
S-6-1	Bearing 8, North Abutment	The east anchor bolt is broken.

BR 1-745 Substructure Defects

Defect Number	Location	Defect Description
A-1-1	Southwest wingwall	6" wide x 6" high x 2" deep spall.
A-1-2	South Abutment Slope	Erosion along both sides of the riprap at midwidth of the bridge, full height of the slope x up to 2'-0" wide x up to 2'-0" deep.
A-1-3	Bays 2 and 3, South Abutment Stem	30% area of delaminated concrete.
A-1-4	Bay 4, South Abutment Stem	50% area of delaminated concrete.
A-1-5	Bay 5, South Abutment Stem	70% area of delaminated concrete and 1/8" wide horizontal cracks.
A-1-6	Bay 6 Backwall, South Abutment	4'-0" wide x 2'-0" high x 1/2" deep spall.
A-1-7	Bay 8 Backwall, South Abutment	1'-3" long x 1'-0" high x 3" deep spall.
A-1-8	Bay 11, South Abutment	8'-0" long x 6" high area of delaminated concrete in the stem continues 6" into the beam seat.
A-1-9	Bay 12 Stem, South Abutment	Two (2) 4'-0" long x 1/8" wide cracks.
A-1-10	Bay 13-16 Stem, South Abutment	21'-0" long x 1/8" wide horizontal crack.
A-1-11	Bay 14, South Abutment	1/8" wide map cracking throughout the backwall.
P-1-12	Pier 1 Cap, North Face, Bearing stiffener at Column 2	3/16" remaining at the bottom 3" of the stiffener.
P-1-13	Pier 1 Cap, Bay 9	Two (2) loose bolts on the east full height diaphragm.
P-1-14	Pier 1 Cap, Bay 10	Two (2) loose bolts on the east full height diaphragm.
P-1-15	Pier 1 Cap, Bay 11	One (1) bolt at access grate unable to be removed to gain entry.
P-1-16	Pier 1 Cap, Bay 12	Two (2) loose bolts on the east full height diaphragm.

BR 1-745 Substructure Defects (Continued)

Defect Number	Location	Defect Description
P-1-17	Pier 1 Cap, East Overhang	Access grate not fully tightened down.
P-1-18	Pier 1, Column 1, North Face	1'-0" wide x 5'-0" long area of delaminated concrete.
P-1-19	Pier 1, Column 1, North Face	1'-0" wide x 1'-0" high x 1/2" deep spall.
P-1-20	Pier 1, Column 2, West Face	1'-0" wide x 1'-6" long are of delaminated concrete.
P-1-21	Pier 1, Column 2, North Face	3'-0" wide x 4'-0" long area of delaminated concrete with a 6" wide x 6" high x 1/2" deep spall.
P-1-22	Pier 1, Column 2, Top Northeast Corner	6" wide x 1'-0" high x 3" deep spall on the east face and a 1'-0" wide x 2'-0" high area of delaminated concrete with a 1'-0" x 3" x 3" deep spall on the north face.
P-1-23	Pier 1, Column 2, East Face	Full width x 2'-6" long area of delaminated concrete with up to 1.5" deep spall with exposed corroded reinforcement and a full width x 1/8" wide horizontal crack.
P-1-24	Pier 1, Column 2, East Face	The bottom half of the column is delaminated for a 3'-0" width with multiple 1.5" deep spalls.
P-2-1	Pier 2 Cap, South Face, Between Beams 8 and 9	2" x 2" area of 100% section loss in the bottom of the stiffener.
P-2-2	Pier 2 Cap, West Overhang	Broken access grate.
P-2-3	Pier 2 Cap, Bay 15	One (1) bolt at access grate unable to be removed to gain entry.
P-2-4	Pier 2 Cap, East of Beam 16	Bolts at access grate unable to be removed to gain entry.
P-2-5	Pier 2, Column 2, Southeast Corner	20'-0" long x 1/16" wide crack in chamfer.
P-2-6	Pier 2, Column 3, South Face	Up to 10" long x 1/16" wide crack at mid height.
P-2-7	Pier 2, Column 3, East Face	Up to 10" long x 1/16" wide crack at mid height.
P-2-8	Pier 2, Column 3, East Face	1/16" wide vertical and map cracking throughout the top 2'-0" of the column.
P-2-9	Pier 2, Column 3, South Face	1'-3" wide x 1'-3" long area of delaminated concrete with up to 1/2" spalling with exposed corroded reinforcement.
P-2-10	Pier 2, Column 3, South Face	1'-6" wide x 1'-6" high area of delaminated concrete.
P-2-11	Pier 2, Column 3, South Face	Full width x 3'-2" long x 6" deep spall with exposed corroded reinforcement.
P-2-12	Pier 2, Column 3, West Face	1'-6" wide x 2'-6" long area of delaminated concrete.
P-2-13	Pier 2, Column 3, West Face	9" wide x 2'-6" long area of delaminated concrete.
P-2-14	Pier 2, Column 3, East Face	6" wide x 3'-2" long area of delaminated concrete.
P-2-15	Pier 2, Column 3, Top Face	1'-0" wide x 1'-6" long area of delaminated concrete.
P-2-16	Pier 2, Column 3, Top Face	8" wide x 1'-6" long area of delaminated concrete.
P-2-17	Pier 2, Column 3, Top Face	7" wide x 1'-0" long area of delaminated concrete.
P-2-18	Pier 2, Column 3, Top Face	7" wide x 1'-0" long x 3" deep spall.
P-3-1	Pier 3 Cap, Bay 6	Loose nut on the bolt in the angle connection at the bottom of the west half diaphragm.
P-3-2	Pier 3 Cap, Bay 7	The north bolt of the east diaphragm is misaligned up to 1/2".

BR 1-745 Substructure Defects (Continued)

Defect Number	Location	Defect Description
P-3-3	Pier 3 Cap, Bay 9, East side of west full diaphragm	Missing bolt.
P-3-4	Pier 3 Cap, Bay 12	Two (2) bolts at east full height diaphragm are loose.
P-3-5	Pier 3 Cap, Bay 13	One (1) bolt at east full height diaphragm is loose.
P-3-6	Pier 3, Column 1, East Face	8" wide x 2'-0" long x 4" deep spall.
P-3-7	Pier 3, Column 1, South Face	3" wide x 2'-0" long x 4" deep spall.
P-3-8	Pier 3, Column 3, South Face	3'-0" wide x 2'-0" long area of delaminated concrete with up to 1.5" deep spalling and an associated 1/8" wide crack at the southeast corner.
P-3-9	Pier 3, Column 3, East Face	5'-0" wide x 3'-0" long area of delaminated concrete.
P-3-10	Pier 3, Column 3	1'-6" wide x 1'-0" high area of delaminated concrete with a 1/2" deep spall.
P-4-1	Pier 4 Cap, South Face, Between Beams 8 and 9	1/4" remaining of stiffener due to pitting at bottom 5".
P-4-2	Pier 4 Cap, South Face, Between Beams 11 and 12	1/4" buckling over a 6" height at the intermediate stiffener.
P-4-3	Pier 4, Column 1, South Face	Disconnected and clogged drain pipe (see Photo 7).
P-4-4	Pier 4 Cap, West Overhang	Broken access gate.
P-4-5	Pier 4 Cap, Bay 13	2'-9" long missing vertical weld extending from top continuing 2'-3" at the south edge of the east full height diaphragm (see Photo 12).
P-4-6	Pier 4 Cap, Bay 13	9" long missing vertical weld on the east face of the east half height diaphragm at south edge (see Photo 12).
P-4-7	Pier 4, Column 1, South Face	2'-0" wide x 2'-6" long x 1" deep spall.
P-4-8	Pier 4, Column 1, South Face	Up to 15'-0" long x 1/16" wide vertical crack.
P-4-9	Pier 4, Column 1, Northeast Corner	1'-0" wide x 2'-0" high area of delaminated concrete in a previous repair.
P-4-10	Pier 4, Column 2, East Face	6" wide x 1'-0" long area of delaminated concrete with a 2" deep spall with exposed corroded reinforcement.
P-4-11	Pier 4, Column 2, North Face	3'-0" wide x 2'-0" long area of delaminated concrete.
P-4-12	Pier 4, Column 3, Southwest Corner	1/16" wide vertical crack with rust staining along the bottom half of the column.
P-5-1	Pier 5 Cap, North Face, West End	Pitting up to 1/4" deep on top of bottom flange around the base of the seat plate. Heavy rust at the bottom 3" of the web.
P-5-2	Pier 5 Cap, North Face, Bearings 2-7	Rust and delamination on the bottom flange.
P-5-3	Pier 5, Column 1, East Face	1'-8" wide x 2'-0" high area of delaminated concrete.
P-5-4	Pier 5, Column 1, East Face	2'-0" wide x 3'-0" high area of delaminated concrete.
P-5-5	Pier 5, Top of Column 2, East Face	1'-4" wide x 2'-4" high area of delaminated concrete with two (2) 1/16" wide vertical cracks.

BR 1-745 Substructure Defects (Continued)

Defect Number	Location	Defect Description
P-5-6	Pier 5 Cap, West Overhang	Broken access grate.
P-5-7	Pier 5 Cap, Bay 4	One (1) bolt is loose at the west half height diaphragm.
P-5-8	Pier 5 Cap, Bay 5	One (1) bolt is loose at the west half height diaphragm.
P-5-9	Pier 5 Cap, Bay 6	One (1) bolt at access grate unable to be removed to gain entry.
P-5-10	Pier 5 Cap, Bay 10	The west full height diaphragm is missing one (1) bolt.
A-6-1	North Abutment Slope	Erosion along both sides of the riprap at midwidth of the bridge, full height of the slope x up to 2'-0" wide x up to 2'-0" deep.
A-6-2	North Abutment Slope	Up to 2'-0" deep x full bay width erosion at the west end.
A-6-3	Bay 1 Backwall, North Abutment	1'-3" wide x 2'-0" high x 1.5" deep spall.
A-6-4	Bay 1 Stem at Erosion	8" diameter x 1/4" deep spall.
A-6-5	Bay 2 Stem, North Abutment	2'-0" wide x 2'-0" high x 2" deep spall.
A-6-6	Bay 2 Beam Seat, North Abutment	2'-0" long x 1/8" wide horizontal crack.
A-6-7	Bay 2-3 Stem, North Abutment	16'-0" long x 1/8" wide horizontal crack in the stem.
A-6-8	Bay 3 Stem, North Abutment	2'-0" x 2'-0" area of delaminated concrete.
A-6-9	Bay 3 Backwall, North Abutment	2'-0" wide x 2'-0" high area of delaminated concrete.
A-6-10	North Abutment Stem, Below Beam 5	1'-6" wide x 2'-0" long delaminated patch.
A-6-11	Bay 6 Stem, North Abutment	7" wide x 1'-0" long area of delaminated concrete.
A-6-12	North Abutment Stem below Beam 8	1'-0" wide x 1'-4" long area of delaminated concrete.
A-6-13	Bay 8 Stem, North Abutment	8" diameter area of delaminated concrete.
A-6-14	Bay 8 Backwall, North Abutment	7" high x 1'-0" long x 1.5" deep spall.
A-6-15	Bay 9 Stem, North Abutment	1'-0" high x 10' long area of delaminated concrete.
A-6-16	Bay 11 Stem, North Abutment	6" high x 2'-4" long area of delaminated concrete.
A-6-17	Bay 14 Stem, North Abutment	4'-0" x 1'-0" area of delaminated concrete.
A-6-18	North Abutment Stem, East End	6" wide x 2'-0" long area of delaminated concrete.
A-6-19	Bays 11 and 12, North Abutment Stem	Top 10" of the vertical face is delaminated in Bay 11 and half of Bay 12.
A-6-20	Bay 14 Backwall, North Abutment	5'-0" wide x 3'-0" high area of delaminated concrete.
A-6-21	Bay 15 Stem, North Abutment	2'-0" wide x 1'-0" high area of delaminated concrete.
A-6-22	North Abutment Slope, East end	Erosion for the full height of the slope in the last bay.
A-6-23	North Abutment Stem, East Corner	1'-0" wide x 2'-0" high x 3" deep spall.

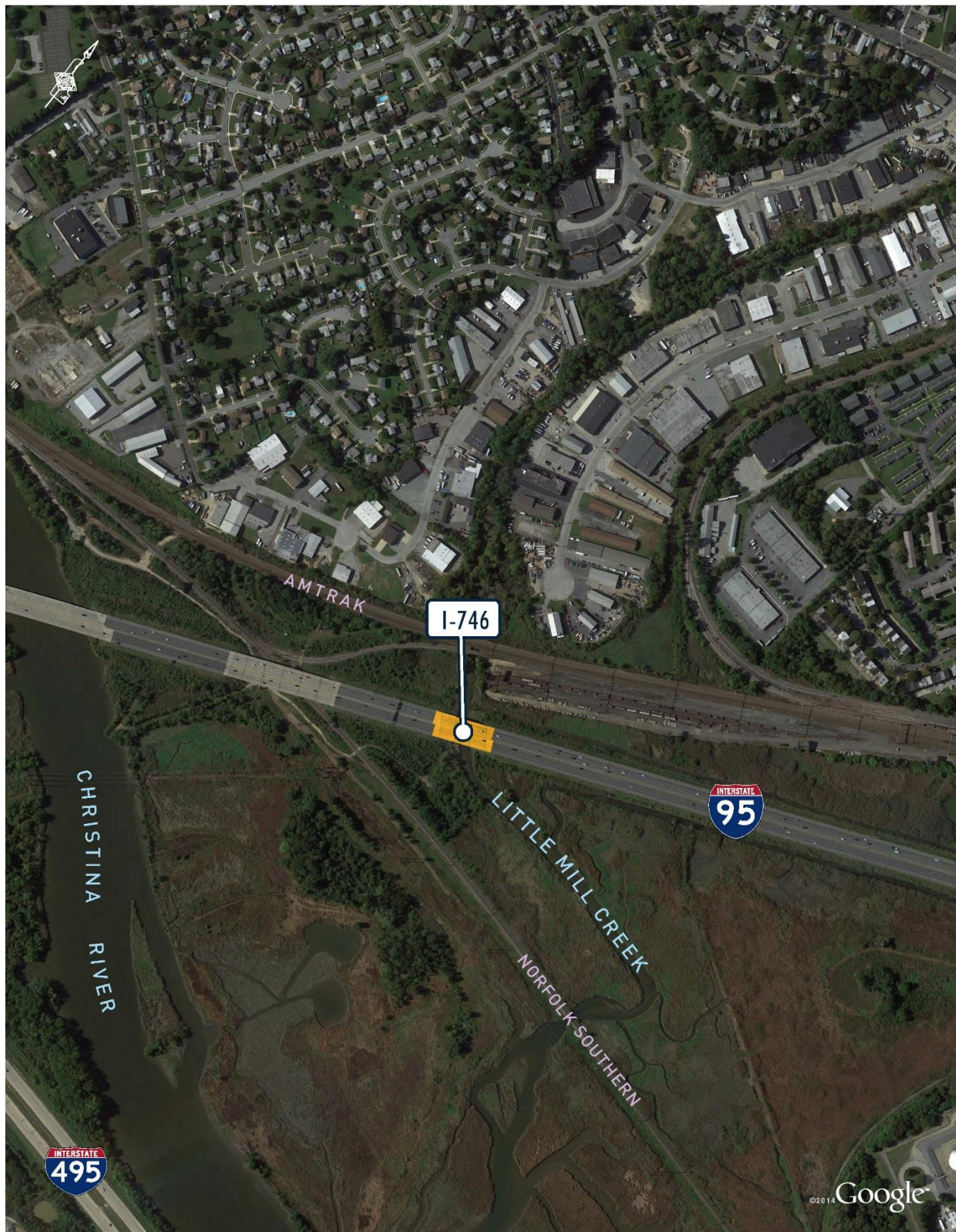
4.11 Bridge 1-746

4.11.1 Bridge Description

Bridge 1-746 is located on I-95 over Little Mill Creek (see Location Map in Section 4.11.2). This structure is a three (3) span simply supported steel beam bridge built in 1962, widened in 1980, and rehabilitated in 2004. The bridge has an overall length of 207'-0"± measured from centerline of abutment bearings with span lengths of 68'-9"±, 69'-6"±, and 68'-9"±. The bridge has an out-to-out width of 111'-0"± providing a clear roadway width of 52'-5"± in each direction. The bridge carries six (6) lanes of traffic on I-95, three (3) lanes each in the northbound and southbound directions. The superstructure consists of sixteen (16) painted steel rolled beams with welded cover plates supporting a 7 ½"± thick reinforced concrete deck. According to plans, the existing deck is protected with a 2" thick LMC overlay. Both the median and outside shoulder barriers are 2'-8" high jersey shape reinforced concrete parapets. The substructure consists of reinforced concrete hammerhead piers and reinforced concrete stub abutments.

Note, the numbering convention used in this report follows the numbering convention used in the biennial inspection reports where the first span is numbered 1. This is the same numbering convention used in the plans.

4.11.2 Location Map



4.11.3 NDE Plan

The bridge deck was surveyed using NDE methods in order to assess the condition of the structural concrete deck. The goal of the NDE program was to determine the structural concrete deck's remaining service life and the proposed approximate quantity of structural concrete deck repairs. The assessment was conducted using IE methodology in order to determine the location and severity of observed debonding between the base structural concrete deck and the LMC overlay, and delaminations within the base structural deck. The single lane in the southbound direction was surveyed using IE methodology. A 2' long x 2' wide grid was marked on the bridge deck using water soluble paint and the eighteen (18) spans, or 18 "span-lanes" were tested.

4.11.3.1 NDE Results

The following is a summary of the NDE results. Delaminations are defined as predominately horizontal cracks found in the base structural deck, while debonding is defined as a separation or loss of bond between the base structural deck and the LMC overlay. Results are presented with an IE deck condition rating from 0 to 100 (these are relative condition ratings with respect to each project bridge and cannot be compared to any other bridges) and an overall IE deck condition state of Good, Fair, Poor, or Serious, quantified by deck area percentage (%). Good (or "sound") is defined by the lack of delaminations within the base structural deck. Fair is defined as the potential presence of initial delamination described as occasional (local) separations within the deck. Poor is defined as the presence of a continuous delamination of a smaller width, relative to the depth, or thickness, of the deck. In many cases, it cannot be detected by chain drag or hammer sounding as it is often outside the audible range given the delamination is located deeper within the deck between the top and bottom mats of reinforcing steel. Serious is defined as a continuous delamination of a larger width, relative to the depth and is a result of flexural oscillations of the delaminated part of the deck. It is in the audible range. Areas of the deck in serious condition can be detected by chain drag or hammer sounding given the delamination is located at or near the top mat of reinforcing steel. Note that the IE deck condition states do not correlate with the NBI visual condition state ratings of 7, 5, 4, or 3, respectively. For further information and complete results, please reference the full NDE report in Appendices B and C.

This bridge has an overlay varying between 1.25" and 3". On average, 46% of the deck area shows no signs of delamination. Approximately 45% is in a state of incipient delamination, which can be described as a state where there are signs of a discontinuous delamination (the deck has intermittent cracking, but is mostly connected). 10% of the deck area is in a state of fully developed delamination. For an overlay of this thickness, it is expected that the serious condition represents debonding of the overlay. However, it is possible that the debonding is underlain by delamination. The southbound bridge deck is slightly more deteriorated, especially the right lane. More delaminated areas were also detected in Spans 2 and 3 of the middle lane of the northbound bridge. Overall, the deck is in fair condition.

4.11.4 Concrete Coring Plan

A total of eight (8) 3.25" diameter concrete core samples, 5" to 7" long, were extracted and laboratory tested in accordance with ASTM C42. Compressive strength testing was performed on the structural layers of the deck only, excluding any portion of the LMC overlay in accordance with ASTM C39. Six (6) cores were tested for compressive strength, two (2) of which were additionally tested for water soluble chloride ions in accordance with ASTM C1218. Two (2) cores were sent to Highbridge Materials Consulting, Inc. for petrographic examination and air-void analysis in accordance with ASTM C856 and ASTM C457, respectfully.

4.11.4.1 Concrete Core Results

The following is a summary of the concrete coring results; for further information, please reference the full report in Appendix D.

The design strength of the concrete deck is 3000 psi. The tested cores resulted in an average compressive strength of 5341 psi, with a range of 3390 psi to 6710 psi.

Three (3) depth results in the base structural deck (0.5", 1", and 2") were obtained from the water soluble chloride ion core sample. The top layer of steel is located at 1.5" according to the plans. The chloride content is 0.365 lbs./c.y at the 0.5" depth, 0.24 lbs./c.y. at the 1" depth, and 0.145 lbs./c.y. at the 2" depth. In accordance with DelDOT's Bridge Design Manual May 2005 Figure 9-1, a level of chloride contamination from 0 to 1.3 is considered low, 1.3 to 2.0 is considered moderate, and greater than 2.0 is considered advanced. Therefore chloride contamination in the upper and lower layers is considered low.

4.11.4.2 Petrographic Analysis Results

Cores 746NB-1P and 746 SB-1P were sent to Highbridge Materials Consulting, Inc. for petrographic and air voids analysis. The following is a summary of the test results. For further information please reference the "*Petrographic Examination Report*" prepared by Highbridge Materials Consulting, Inc. dated March 22, 2015, in Appendix E.

The petrographic analysis of the cores indicated that the concrete materials were generally well mixed. The concrete also appears to have been cast and consolidated in accordance with industry standard practices. The water to cement ratio for the core is estimated to be in the mid to high 0.40's. Core 746NB-1P had trace evidence of early stage ASR in the form of axial micro-cracking. However, the reaction is in its very early stages and does not impose an imminent threat to the stability of the concrete.

The total air voids observed in core 746NB-1P was 4.7% and the total air voids observed in core 746SB-1P was 1.1%. Current specifications for concrete exposed to freezing and thawing cycles, per ACI 318 Chapter 4 Section 4, are considered within acceptable limits from 3.5% to 6.5%. The results for core 746NB-1P were found to be within this specification. The results for core 746SB-1P are outside the limits and would generally be unacceptable for freeze thaw resistance.

4.11.5 Paint Adhesion Testing

Paint adhesion testing was performed on pre-selected locations throughout the viaduct on representative areas of distressed or peeling paint, in addition to areas where the coating system was intact. A NACE Level 1 certified inspector performed the test utilizing a portable adhesion tester in accordance with ASTM D4541. At each test location, the inspector documented a description of the failure (paint vs. adhesive), and the tensile strength (psi). Additionally, the inspector determined and recorded the coating thickness, utilizing an electronic dry film thickness gauge per the procedures outlined in SSPC-PA2. The variability of the testing results summarized in Appendix F suggest further testing locations are required. After consultation with the Department, it was agreed the entire superstructure will be repainted.

4.11.6 Summary of Findings

The following is a summary of the visual inspection findings; for further information, please reference the inspection field observation notes in Appendix H.

The deck appears to exhibit widespread poor consolidation of concrete on the underside of Bay 4 and Bay 12 in all three (3) spans (see Photo 1). In some areas, the scaling has exposed steel reinforcement in the underside of the deck. There are other isolated areas of delamination and spalling with exposed steel reinforcement in Bays 5, 14, and 15 (see Photo 2). Bays 6 through 10 have steel stay-in-place forms that are in good condition. The top of the deck has some isolated spalls in the LMC overlay, up to 2" deep. There is also scaling up to ¼" deep in Span 1, southbound. All of the expansion joints in the bridge are clogged with dirt. The joint over Pier 1 on the north bound span shows signs of leakage to the bearings. The underside of the parapets have numerous failed repairs where steel reinforcement is exposed. The average size of these failed repairs/spalls is 6"x6"x2" deep.

The superstructure exhibits small areas of paint blistering and chalking at the beam ends and on the bearings. At Span 1, Pier 1, Bay 4, there is an area of pack rust on the end diaphragm where the joint failed and water began leaking through. There are bird nests and insect hives throughout the underside of the superstructure (see Photo 5). There are also some isolated areas of graffiti at the beam ends near the abutments (see Photo 6). Approximately 30% of the bearing anchor nuts are not fully engaged.

The substructure exhibits map cracking throughout the repaired areas, but the concrete appears to be sound (see Photo 8). There are widespread delaminated areas in the concrete at the beam seat of both abutments. Water is ponding on the beam seats from the leaking expansion joints above at both abutments. Many of the previous repair patches on the piers are map cracked, but most of the patches are sound with only a few delaminated areas present. At the south face of Pier 2, Bearing 4 is partially undermined by a 6" deep spall at that location (see Photo 10). There are some vertical cracks present in the piers and abutments, up to 1/8" wide. These cracks are not widespread. Scour holes were observed at the north face of the base of all three pier columns that make up Pier 2 (see Photo 11). These holes extended the full face of the pier column, up to 10' wide, and 2' deep.

4.11.6.1 Defect Photographs

The defect photos are representative of the as-inspected condition; additional photos are available upon request.



Photo 1: Poor consolidation of concrete on underside of deck (Span 3, Bay 4 shown)



Photo 2: Typical local spalls with exposed rebar in the underside of the deck (Span 1, Bay 4 shown)



Photo 3: Typical bearing with areas of rust (South Abutment, Bearing 4 shown)



Photo 4: Typical localized paint rusting and chalking (Span 1, Pier 1, Bay 4 end diaphragm shown)



Photo 5: Typical insect hives throughout superstructure (Span 3, Bay 3 shown)



Photo 6: Typical Graffiti at beam ends (Span 1, Girder 16 shown)



Photo 7: Water ponding on beam seat (Span 3, North Abutment, Bay 4)



Photo 8: Map cracking on substructure (Span 3, Pier 2, west hammerhead shown)



Photo 9: Typical horizontal 1/16" crack in pier cap (Span 2, Pier 2)



Photo 10: Spall undermining bearing at Span 2, Pier 2, Bearing 4)



Photo 11: Typical scour at Pier 2 (Span 3, Center pier column)

4.11.7 Defect Tables

BR 1-746 Deck Defects

Defect Number	Location	Description
D-1-1	Span 1, Bay 4 Soffit	Scaling in the underside of the deck for the full length of the span and full width of the bay.
D-1-2	Span 1, Bay 4 Soffit	1'-6" x 8" x 3" deep spall with exposed reinforcement in the underside of the deck.
D-1-3	Span 1, Bay 5 Soffit	1'-8" x 3" area of delaminated concrete in the underside of the deck.
D-1-4	Span 1, Bay 14 Soffit	8" x 8" x 1" deep spall in the underside of the deck with exposed reinforcement.
D-1-5	Span 1, Bay 14 Soffit	1'-0" x 6" x 1" deep spall with exposed reinforcement in the underside of the deck.
D-1-6	Span 1, Bay 15 Soffit	1'-6" x 7" x 2" area of delaminated concrete in the underside of the deck.
D-2-1	Span 2, Bay 4 Soffit	Scaling up to ½" deep in the underside of the deck for the full length of the span and full width of the bay.
D-3-2	Span 3, Bay 4 Soffit	Scaling up to 1/2" deep in the underside of the deck for the full length of the span and full width of the bay.
D-3-3	Span 3, Bay 5 Soffit	8" x 4" x 1/2" deep spall in the underside of the deck with exposed reinforcement.
D-3-1	Span 3, Bay 5 Soffit	2'-0" x 1'-6" x 3" spall with exposed reinforcement in the underside of the deck.

BR 1-746 Superstructure Defects

Defect Number	Location	Description
S-1-1	Bearing 2, South Abutment	West anchor bolt at Bearing 2 is loose at the South Abutment.
S-1-2	Bearing 3, South Abutment	West anchor bolt at Bearing 3 is loose at the South Abutment.
S-1-3	Bearing 2, Pier 1, Span 1	Moderate rust at Bearing 2 at Pier 1.
S-1-4	Bay 4, Pier 1, Span 1	Paint failure on the end diaphragm and bearing at Pier 1, Bay 4.
S-1-5	Bearing 4, South Abutment	Moderate rust at Bearing 4 at the South Abutment.
S-1-6	Bearing 5, Pier 1, Span 1	Random areas of rust on Bearing 5 at Pier 1.
S-1-7	Bearing 7, South Abutment	East anchor bolt at Bearing 7 is loose at the South Abutment.
S-1-8	Bearing 16, South Abutment	West anchor bolt is loose at Bearing 16 at the South Abutment.
S-2-1	Bay 5, Span 2	2'-0" of blistered paint on the top flange of Girder 5 near Pier 1.
S-3-1	Bearing 1, North Abutment	Rust staining at Bearing 1 on the North Abutment.
S-3-2	Girder 4, Span 3	1'-6" long area of blistered paint on the top flange at the end of Girder 4 near Pier 2.

BR 1-746 Superstructure Defects (Continued)

Defect Number	Location	Defect Description
S-3-3	Bearing 4, Pier 2, Span 3	Paint failure on Bearing 4 at Pier 2.
S-3-4	Bearing 13, North Abutment	Rust staining on Bearing 13 at the North Abutment.

BR 1-746 Substructure Defects

Defect Number	Location	Description
A-1-1	South Abutment, East Wingwall	Moderate map cracking on east wingwall of the South Abutment.
A-1-2	South Abutment, West Wingwall	1'-10" x 2" x 1" deep spall on the west wingwall of the South Abutment.
A-1-3	South Abutment, West Wingwall	2'-6" long x 1/16" wide horizontal crack in west wingwall of South Abutment.
A-1-4	South Abutment	Hollow areas up to 2'-0" SF scattered throughout beam seat.
A-1-5	South Abutment	2'-6" long x 1/16" wide vertical crack in front stem of South Abutment.
A-1-6	South Abutment	1'-6" x 6" x 3" deep in the back wall of the South Abutment.
A-1-7	South Abutment	5'-6" long x 1/16" wide horizontal crack in front stem of South Abutment.
A-1-8	South Abutment Stem, Under Bearing 4	4'-6" long x 1/16" wide horizontal crack in front stem of South Abutment under Bearing 4.
A-1-9	South Abutment Stem, Under Bearing 4	2'-6" long x 1/8" wide horizontal crack in front stem of South Abutment under Bearing 4.
A-1-10	South Abutment Backwall, Bay 4	Full height 3/32" vertical crack in back wall of South Abutment.
A-1-11	South Abutment Stem, Bay 12	5'-6" long x 1/8" wide horizontal crack in front stem of South Abutment.
A-1-12	South Abutment Backwall, Bay 13	2'-0" long x 1/16" wide vertical crack in back wall of South Abutment.
A-1-13	South Abutment, Bay 13	Water ponding on beam seat.
A-3-1	North Abutment, West Wingwall	Moderate map cracking on west wingwall of the North Abutment.
A-3-2	North Abutment, East Wingwall	Moderate map cracking on east wingwall of the North Abutment.
A-3-3	North Abutment Stem, Bay 1	4'-6" long x 1/8" wide horizontal crack in front stem of North Abutment.
A-3-4	North Abutment Stem, Bay 2	6'-0" long x 1/16" wide horizontal crack in front stem of North Abutment.
A-3-5	North Abutment Stem, Bay 2	4'-0" long x 1/8" wide vertical crack in the front stem of the North Abutment.
A-3-6	North Abutment, Bay 2	Water ponding on beam seat.
A-3-7	North Abutment, Bay 3	Water ponding on beam seat.

BR 1-746 Substructure Defects (Continued)

Defect Number	Location	Defect Description
A-3-8	North Abutment, Bay 4	Water ponding on beam seat.
A-3-9	North Abutment Stem, Bay 4	3'-6" long x 1/16" wide horizontal crack in front stem of North Abutment with rust staining.
A-3-10	North Abutment Backwall, Bay 4	5'-0" long x 1/16" wide vertical crack in the back wall of the North Abutment.
A-3-11	North Abutment, Bay 6	1'-6" x 2" deep edge spall in the front of the North Abutment.
A-3-12	North Abutment, Bay 9	1'-4" x 2" edge spall at beam seat.
A-3-13	North Abutment, Bay 12	Water ponding on beam seat.
A-3-14	North Abutment, Bay 13	Water ponding on beam seat.
A-3-15	North Abutment Stem, Bay 14	4'-0" long x 1/8" wide horizontal crack with rust staining in front stem of North Abutment.
A-3-16	North Abutment Stem, Bay 15	2'-2" long x 1/8" wide diagonal crack with rust staining in the front stem of the North Abutment.
A-3-17	North Abutment Backwall at Girder 16	1'-0" long x 1/8" wide diagonal crack at in the back wall of the North Abutment near Girder 16.
P-1-1	Pier 1, Bay 3, South Face	1'-6" long x 1/16" wide horizontal crack in south face of pier cap at Pier 1.
P-1-2	Pier 1, Bay 12, South Face	2'-0" SF of map cracking with cracks up to 1/16" wide in south face of the Pier 1 pier cap, 3'-0" below bearings.
P-2-3	Pier 1, Bay 4, North Face	6'-0" long x 1/16" wide horizontal crack and area of delaminated concrete in the north face of pier cap of Pier 1.
P-2-4	Pier 1, Bay 9, North Face	6'-0" x 6'-0" area of delaminated concrete below Bearing 9 on the north face of the pier cap of Pier 1.
P-2-1	Pier 2, Bay 2, South Face	3'-0" long x 1/16" wide horizontal crack below Bearing 2 in the south face of Pier 2.
P-2-2	Pier 2, Bay 4, South Face	1'-3" x 6" x 6" deep spall undermining the corner of Bearing 4 on the south face of Pier 2.
P-2-3	Pier 2, Bay 12-13, South Face	10'-0" long x 1/8" wide horizontal crack in the south face of Pier 2.
P-2-4	Pier 2, Bay 13, South Face	4'-0" long x 3/32" wide vertical crack in the south face of Pier 2.
P-2-5	Pier 2, West Pier Column, North Face	5'-8" x 10'-0" x 7" deep scour hole at the north face of the west pier column of Pier 2.
P-2-6	Pier 2, Center Pier Column, North Face	Scour hole extending the full width of the center pier column of Pier 2 and 1'-4" deep at the north face of the pier column,
P-2-7	Pier 2, East Pier Column, North Face	12'-0" x 6'-0" x 2'-0" deep scour hole at the base of the north face of the east pier column of Pier 2.
P-2-8	Pier 2 end	5'-0" SF of map cracking on end of Pier 2, up to 1/16" wide.
P-2-9	Pier 2, Bay 2, North Face	4'-3" long x 1/16" wide crack in north face of Pier 2.
P-2-10	Pier 2, Bay 3, North Face	5'-0" long x 1/16" wide crack under Bearing 3 on north face of Pier 2 pier cap.
P-2-11	Pier 2, Bay 3-4, North Face	2'-0" long x 1/8" wide horizontal crack with rust staining under Girder 4 in the north face of Pier 2.

BR 1-746 Substructure Defects (Continued)

Defect Number	Location	Defect Description
P-2-12	Pier 2, Bay 4-5, North Face	Four (4) cracks up to 3'-0" long x 1/16" wide in the north face of Pier 2.
P-2-13	Pier 2, Bay 12, North Face	3'-0" to 4'-0" long x 1/8" wide horizontal cracks in the north face of the Pier 2 pier cap.
P-2-14	Pier 2, Bay 13, North Face	4'-0" long x 1/8" wide horizontal crack with rust staining in the north face of the Pier 2 pier cap.

5.0 Summary of Recommendations

Based on the results of the design level inspection, associated NDE and testing, and several meetings and discussions with Department staff, the recommendations for the repair of the Wilmington Viaduct and its associated project bridges are identified by three (3) categories, including monitoring/testing, repair, and design. Because the start of construction for the rehabilitation project is currently scheduled to begin in 2019, it is critical to evaluate the condition of the bridges at that time and compare it to its current condition in 2015. A systematic monitoring/testing program including NDE, cores, and hands-on inspection of critical elements should be programmed to validate the recommendations proposed herein for repair and design. Repair recommendations represent the required rehabilitation needs of the bridge to ensure it remains in sound condition and will have adequate remaining service life available to extend its service life a minimum of 30 years. Design recommendations include items to improve the functionality of the bridge, provide enhancements to meet current design codes and standards, and address other potential design and detail deficiencies that have been identified during the inspection and/or by others. The monitoring/testing recommendations should be scheduled and completed within one (1) year before the current PS&E date, or December 2017. The repair and design recommendations should be incorporated into the rehabilitation contract documents. The project is scheduled for construction in September 2019.

Similar to previous sections in this report, recommendations are provided for each project bridge. Each bridge is presented in the same order as identified in Section 4.0. Approximate quantities are also provided for each major repair item. Note that no final design computations were completed to confirm the quantities for the design recommendation items.

5.1 Monitoring/Testing Recommendations

Monitoring recommendations include re-inspection of areas with structural effects that have progressed since the current 2014/2015 design level inspection. The scope and limits of the inspection should be determined by reviewing the 2015 and 2017 bridge safety inspection reports and then performing a design level inspection of only those elements that have significantly changed. If the condition of the bridges have not changed significantly, then a visual inspection of the bridges should be performed at a minimum to identify areas of the structure where repair quantities may have increased based on advancing deterioration.

Additional testing of the deck is recommended using the IE technique as used for the design level inspection. Random areas along the deck in serious condition (red colors) as well as those in fair condition (green colors) should be tested to determine if additional delamination of the deck has occurred (reference the delamination condition maps in Appendix C). It is anticipated that given the current condition of the deck at present, based on the findings of the IE, it is possible that up to 50% of the bridge deck in fair condition at present may exhibit delaminations in five (5) years. This could result in a total deck area with delaminations *possibly* exceeding the 35% distress threshold as summarized in the DRAFT DelDOT Bridge Design Manual, Table 109-2. Deck Repair Evaluation Matrix on page 109-13. However, even if the deck repair recommendation is still valid at the time of the PS&E submittal, it is anticipated that the deck repair quantities could increase resulting in additional project costs and a potential increase in construction duration.

5.2 Repair Recommendations

At this time, it is recommended to mill the existing LMC overlay and place a new LMC overlay. The milling should be completed to a minimum of 1/4" into the base structural deck to ensure good bond. The existing joints should be replaced with a new strip seal system sized for the span lengths contributing to expansion. Other deck-related repairs include, but are not necessary limited to, salvage and reinstall the protective shields affixed to the top of the barriers, replace chain link fence also affixed to the top of the barriers, and perform concrete deck repairs following removal of the overlay (i.e., 1" to 3½" depth, 3½" to < full-depth, and full-depth repairs).

Based on the condition and age of the existing paint system, complete cleaning and repainting is recommended for all project bridges. While the bearings on the mainline viaduct have been rehabilitated in the past, given the failure of the joint systems, these bearings have experienced corrosion and build-up of some pack rust affecting long term service life and proper function. These should be cleaned, painted, and lubricated. Some of the bearings, however, exhibit corrosion that inhibits their ability to function properly and/or have experienced misalignment and will require complete replacement. Temporary support via jacking of the superstructure will be required to properly remove and replace these bearings. Other superstructure-related repairs include, but are not necessarily limited to, removal of old sign support structures at fascia girders, tighten/replace connection bolts/rivets, tighten/replace anchor bolt nuts, grind and remove tack welds, and strengthen girder ends with bolted repair plates.

Substructure repair recommendations include performing both shallow (<2" deep) and deep spall (at least 1" behind reinforcing steel) repairs on concrete piers and abutments as well as using epoxy injection to seal any cracks that are >1/16" wide. Subsequent to these repairs, apply a silicone acrylic sealer to preserve the concrete and provide a more uniform and clean appearance. Other substructure-related repairs include, but are not necessarily limited to, remove debris from pier caps, clean and paint the inside and outside of the fracture critical steel cross girders, clear vegetation growth around various substructure units, replace drainage downspouts, and reconfigure the drainage system to more effectively drain the bridges.

For more detailed information, reference the various repair recommendation tables in sections 5.4.1 – 5.4.11 for each project bridge. Recommendations are presented by each major bridge component including deck, superstructure, and substructure.

5.2.1 Summary of Assumptions for Deck Repair Quantity Calculations

NDE of the project bridges was conducted using the IE method to assess the condition of the deck with respect to delamination. Delaminations are defined as predominately horizontal cracks found in the base structural deck, while debonding is defined as a separation or loss of bond between the base structural deck and the LMC overlay. Results are presented with an IE deck condition rating from 0 to 100, an overall IE deck condition state of Good, Fair, Poor, or Serious, quantified by deck area percentage (%). Note that the IE deck condition states do not correlate with the NBI visual condition state ratings of 7, 5, 4, or 3, respectively. Results of the IE survey were used in conjunction with concrete coring test results to calculate reinforced concrete deck repair quantities for portions of structural concrete deck to remain. The following assumptions were made for the quantity calculations.

For deck sections with an overlay thickness of approximately 2" to 3", deck areas determined by IE to be in serious condition represent debonding between the deck and overlay. Since the overlay is scheduled for replacement throughout the Wilmington Viaduct, this observed debonding between the structural deck and overlay will be repaired. It is possible that delaminations in the structural deck exist below the debonded overlay; however, such delaminations are not detectable by IE.

For deck sections with no overlay or an overlay thickness of less than 2", 100% of deck areas determined by IE to be in serious condition are assumed to represent delaminations in the structural deck. These delaminations can be documented by CMI staff during the construction using traditional chain drag or hammer sounding techniques. A deck repair quantity associated with a serious deck condition has been estimated. Independent of the presence or thickness of overlay, 100% of deck areas determined by IE to be in poor condition are assumed to represent delaminations in the structural deck, however, these are difficult to detect using traditional chain drag or hammer sounding techniques and thus a quantity for the repair of the deck in poor condition has not been included in the estimate.

Based on experience with cores taken while conducting similar NDE surveys, observed delaminations in the structural deck are typically encountered at the top level of steel reinforcement. The delamination level is not constant, but is a curved surface of a variable depth, often arching from one reinforcement bar to another (See *Photo 5.1*).



Photo 5.1: Typical delamination in structural deck.

Concrete delamination at the level of reinforcement is consistent with the findings of the cores taken during this project. For example, Core 1-744 SB-1P was taken from Bridge 1-744 with a measured overlay thickness of $1\frac{1}{2}$ " and the structural cover of $1\frac{1}{2}$ ". The location of the crack in the core is at approximately 3" below the top of the overlay (See Photo 5.2), coinciding with the location of reinforcement. Although the depth is variable, for the purpose of quantifying the proposed repair, it is assumed that the depth of repair will extend 1" beyond the bottom mat of steel reinforcement. To account for repairs that may extend below the depth of reinforcement, 10% of the delaminations are assumed to require a repair depth greater than $3\frac{1}{2}$ ", but less than a full-depth repair. Full-depth repairs are assumed to be required only where indicated by inspection field observations identified as spalling in the soffit.



Photo 5.2: Delamination in concrete core at approximate level of steel reinforcement
(Bridge 1-744, Core 744SB-1P)

5.3 Design Recommendations

The existing bridge parapets exhibit significant horizontal cracking and spalling throughout their entire length on the mainline Wilmington Viaduct and the original associated ramp bridges including BR 1-749, 1-750, and 1-758 as well as the bridges located south of the viaduct, or BR 1-744, 1-745, and 1-746. In addition, the parapets do not meet current AASHTO interstate design standards for height or strength (i.e., TL-5). As such, the Department requires that all bridge parapets shall be replaced and new parapets be installed as part of this rehabilitation project. To accomplish this design goal, a portion of the deck will have to be removed in order to properly develop the reinforcing steel bars required to resist the TL-5 impact loads. This will require partial removal of the deck extending from mid-bay between the exterior and first interior girder all the way to the fascia. The parapet removal and replacement can be accomplished via traditional staging (for this project, it has been verified that single lane reductions can be used to provide an adequate staging area for construction). However, on the ramp bridges, the clear roadway widths are generally in the 22' to 23' range. Replacing the parapets does not provide adequate room to place a protective double-sided concrete traffic barrier and mobilize the contractor's equipment while maintaining one lane of traffic. If the ramps are closed, the parapets can be replaced one at a time or both at the same time. Given the narrow clear roadway widths available on each of these ramp bridges, the parapets can be reconstructed more efficiently during a full ramp closure. Furthermore, since the remaining limits of the deck associated with the parapet reconstruction are relatively narrow, that portion of the deck can be replaced as well during the ramp closure period without significant impact to the overall construction duration or cost. Therefore, the repair recommendations for these ramps (i.e., BR 1-749, 1-750, 1-758, 1-758E, 1-758F, and 1-758G) include a full deck replacement.

To minimize future maintenance costs, transverse roadway joints located above bearings in the fixed-fixed condition at shared substructure units will be eliminated. A live load continuity pour (LLCP) can be constructed to effectively seal these areas. If desired, the LLCP could also be designed to transfer live load moments from span-to-span as a continuous structural unit.

5.4 Bridge Recommendations

The following sections are a summary of the recommendations.

5.4.1 Wilmington Viaduct (Bridges 1-748, 1-748N, and 1-758S)

Repair Recommendations

Deck Repair Recommendations	Quantity
Replace the joints at the south abutment, Piers 1, 2, 4, 6, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 30, 32, and 51 (1 ½" strip seals).	5,178 LF
Replace the joints at Piers 35, 37, 39, 43, 45, 49, 57, 59, and the north abutment (2" strip seals).	968 LF
Replace the joints at Piers 34, 41, 47, 53 and 55 (3" strip seals).	538 LF
Replace the decorative barrier along the parapets.	2,486 LF
Mill the existing overlay	119,855 SYIN
Repair concrete deck (1" to 3 1/2" depth).	34,240 SF
Repair concrete deck (3 1/2" to < full-depth).	4,510 SF
Repair concrete deck (full-depth).	20 SF
Furnish and install a new LMC overlay.	3,542 CY

Superstructure Repair Recommendations	Quantity
Remove old sign support connection diaphragms at fascia beams	15 EA
Tighten loose bolts: Span 1, Bay 9, Diaphragm 3, Span 11, Bay 7, Diaphragm 1.	2 EA
Remove steel below masonry plate Pier Cap Bearing 3, at Pier 11 in Span 11.	1 EA
Replace bottom flange connection rivets in Pier 12 Cap; Pier Cap 22, interior Bay 7; Pier Cap 24, Bay 7; and Pier Cap 24, below Beam 17.	47 EA
Jack and replace misaligned bearings: Pier 12; Bearings 1 and 2 at Pier 28S in Span 29S; Bearings at Pier 35N in Span 35N; Pier 35S in Span 35S; Pier 35S in Span 36S; Pier 37N in Span 38N; Bearings 1, 2, 4, 6 at Pier 37S in Span 38S; Pier 41S in Span 41S; Bearings 43S in Span 43S; Bearing 43S in Span 44S; Bearings 1, 2, & 3 at Pier 49S in Span 49S; Bearing 5 at Pier 51S in Span 51S; Bearings at Pier 51N in Span 52N; Bearings 1, 3, 4, 5, & 6 at Pier 51S in Span 52S; Bearing 6 at Pier 52N in Span 53N; Bearings 1 to 6, & 9 at Pier 53N in Span 53N; Bearings at Pier 53S in Span 53S; Bearings 1, 2, 5, 6, 7, 8, & 9 at Pier 53N in Span 54N; Bearings 2, 4, 5, & 6 at Pier 53S in Span 54S; Bearings at Pier 55N in Span 55N; Bearings at Pier 59S in Span 60S.	120 EA
Remove pack rust in Span 15, Pier 15, Pier Cap Bearing 2 and in Span 16, Pier 16, Pier Cap Bearing 2.	2 EA
Replace anchor bolt nut in Span 15, Pier 15, Pier Cap Bearing 2; east anchor bolt nut for Bearing 6 at Pier 44N in Span 44N; east anchor bolt nut for Bearing 6 at Pier 51N in Span 51N; east anchor bolt nut for Bearing 6 at Pier 51N in Span 52N; and west anchor bolt nut for Bearing 3 at Pier 38N in Span 39N and for Bearing 1 at Pier 40N in Span 40N.	6 EA
Seal hole in Beam 1 top flange in Span 18.	1 EA
Replace bottom flange connection bolts in Pier Cap 20, Interior Bays 10 & 11.	40 EA
Replace bottom flange rivets in Pier Cap 22, interior Bay 7; Pier Cap 24, Bay 7; and Pier Cap 24, below Beam 17.	46 EA
Install repair plates to Beam 17 at Pier 24 in Span 25.	350 LB

Superstructure Repair Recommendations	Quantity
Grind and remove the tack weld at Girders 1 and 2 bottom flange connection with Diaphragm 1 in Span 31S.	2 EA
Remove concrete debris on Pier 34S at Bearing 1.	1 EA
Jack and replace frozen bearings due to pack rust: Bearing 6 at Pier 34S in Span 34S; Bearing 6 at Pier 36N in Span 36N; Bearing 6 at Pier 35S in Span 36S; bearing 5 at Pier 41N in Span 42N; Bearings 1, 3, & 4 at Pier 46N in Span 47N; Bearings 1, 3, 4, & 6 at Pier 49S in Span 49S; Bearings at Pier 50N in Span 50N; Bearings 1 & 6 at Pier 50N in Span 51N; Bearing 6 at Pier 52N in Span 52N; Bearings 1 & 6 at Pier 51S in Span 52S; Bearings 5 & 6 at Pier 52N in Span 53N; Bearings at Pier 53N in Span 54N; Bearing 10 at Pier 59N in Span 60N.	34 EA
Replace west anchor bolt nut for Bearing 3 at Pier 38N in Span 39N and for Bearing 1 at Pier 40N in Span 40N.	2 EA
Tighten anchor bolt nuts for Pier 43 N Cap Bearing 2 in Span 43N.	3 EA
Replace east anchor bolt nut for Bearing 6 at Pier 44N in Span 44N.	1 EA
Weld end diaphragm to Beam 2 bearing stiffener at Pier 46N in Span 47N.	1 LF
Replace east anchor bolt nut for Bearing 6 at Pier 51N in Span 51N.	1 EA
Replace east anchor bolt nut for Bearing 6 at Pier 51N in Span 52N.	1 EA
Clean and paint the steel superstructure.	1,202,179 SF
Remove concrete from Bearing 6 at Pier 3 in Span 3.	1 EA
Clean and lubricate bearings.	1,744 EA

Substructure Repair Recommendations	Quantity
Seal cracks in the concrete substructure.	352 LF
Repair shallow spalls in the concrete substructure.	90 CF
Repair deep spalls in the concrete substructure.	711 CF
Replace downspouts.	23 EA
Replace drainage system.	1 LS
Remove debris from top of pier caps.	8 CY
Clean and seal all substructure units with silicone acrylic concrete sealer.	397,607 SF
Clean and paint the inside and outside of the steel pier caps.	93,238 SF
Clear vegetation growth on substructure units.	1 EA

Design Recommendations

Deck Design Recommendations	Quantity
Remove joint and install deck continuity pour at Piers 3, 5, 7, 29, 31, 33, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, and 58.	1,946 LF
Remove the existing parapets.	1,829 CY
Construct new parapets.	3,011 CY
Replace the decorative barrier along the parapets.	2,486 LF
Replace the chain link fence along the parapets.	187 LF
Remove the deck concrete in the outside bays and overhangs.	2,232 CY
Remove the concrete adjacent to the joints.	1,813 CY
Replace the deck in the outside bays and overhangs.	2,232 CY

5.4.2 Bridge 1-749

Repair Recommendations

Deck Repair Recommendations (Full Deck Replacement)	Quantity
Install joints at Pier 1A, Pier 2A, Pier 5A, and the abutment (1 ½" strip seals).	109 LF
Install a joint at Pier 3A (2" strip seals).	28 LF

Superstructure Repair Recommendations	Quantity
Clean and paint the steel superstructure.	47,886 SF
Jack and replace misaligned Bearings 1 through 4 in Span 2 at Pier 2.	4 EA
Replace west anchor bolt to Bearing 4 in Span 4 at Pier 4 and to Bearing 1 in Span 5 at Pier 4.	2 EA
Clean and lubricate bearings.	48 EA

Substructure Repair Recommendations	Quantity
Seal cracks in the concrete substructure.	35 LF
Repair shallow spalls in the concrete substructure.	4 CF
Repair deep spalls in the concrete substructure.	53 CF
Clean and seal all substructure units with silicone acrylic concrete sealer.	15,461 SF
Replace downspout at Piers 3, 4, & 5.	3 EA

Design Recommendations

Deck Design Recommendations (Full Deck Replacement)	Quantity
Remove joint and install deck continuity pour at Pier 4A.	28 LF
Remove the existing parapets.	183 CY
Construct new parapets.	168 CY
Replace the decorative barrier on the parapets.	204 LF
Remove the concrete deck and approach slab.	407 CY
Replace concrete deck and approach slab.	407 CY
Install a new 1" PPC overlay.	46 CY

5.4.3 Bridge 1-750

Repair Recommendations

Deck Repair Recommendations	Quantity
Install joints at the south abutment, Pier 2, and the north abutment (1 ½" strip seals).	82 LF
Install joint at Pier 1 (2" strip seals).	28 LF

Superstructure Repair Recommendations	Quantity
Clean and paint the steel superstructure.	5707 SF
Jack and replace frozen bearings due to pack rust at Bearing 1 in Span 1 at Pier 1 and Bearing 4 in Span 1 at Pier 1.	2 EA
Clean and lubricate bearings.	24 EA

Substructure Repair Recommendations	Quantity
Seal cracks in the concrete substructure.	7 LF
Repair shallow spalls in the concrete substructure.	4 CF
Repair deep spalls in the concrete substructure.	24 CF
Clean and seal all substructure units with silicone acrylic concrete sealer.	3765 SF
Repair settlement in the abutment slope protections.	3 EA

Design Recommendations

Deck Design Recommendations	Quantity
Remove the existing parapets.	44 CY
Construct new parapets.	41 CY
Remove the existing concrete deck and approach slab.	132 CY
Replace the concrete deck and approach slab.	132 CY
Install a new 1" PPC overlay.	11 CY

5.4.4 Bridge 1-758

Repair Recommendations

Deck Repair Recommendations	Quantity
Install joints at the abutment and at Pier 33 (1 ½" strip seals).	72 LF
Install joints at Pier 1B, Pier 3B, and Pier 5B (2" strip seals).	95 LF
Install a joint at Pier 6B (3" strip seals).	24 LF

Superstructure Repair Recommendations	Quantity
Clean and paint the steel superstructure.	20311 SF
Jack and replace misaligned bearings: Bearing 1 in Span 3 at Pier 3; Pier 5 bearings in Span 5; Pier 6 bearings in Span 6.	9 EA
Replace Bearing 4 anchor bolt nut in Span 2 at Pier 3.	1 EA
Clean and lubricate bearings.	68 EA

Substructure Repair Recommendations	Quantity
Seal cracks in the concrete substructure.	27 LF
Repair shallow spalls in the concrete substructure.	8 CF
Repair deep spalls in the concrete substructure.	48 CF
Replace downspout at Pier 1.	1 EA
Clean and seal all substructure units with silicone acrylic concrete sealer.	11676 SF
Clear debris and install fence at the North Abutment.	90 LF

Design Recommendations

Deck Design Recommendations	Quantity
Remove joint and install deck continuity pour at Pier 2B and Pier 4B.	60 LF
Remove the existing parapets.	139 CY
Construct new parapets.	128 CY
Remove the existing concrete deck.	340 CY
Replace concrete deck.	340 CY
Furnish and install a new 1" PPC overlay.	41 CY

5.4.5 Bridge 1-758E

Repair Recommendations

Deck Repair Recommendations	Quantity
Install joints at Pier 55N and 53N (1 ½" strip seals)	15 LF
Install joints at Pier E6, E9, and E10 (2" strip seals).	73 LF
Install joints at Pier E7, E8, and E11 (3" strip seals).	82 LF

Superstructure Repair Recommendations	Quantity
Clean and paint the steel superstructure.	29325 SF
Remove sole plate at Pier 8, Bearings 3 & 4 and reweld.	2 EA
Replace north anchor bolt and nut at Bearing 5 in Span 1 at Pier 12.	1 EA
Jack and replace misaligned bearings: Pier 8 in Span 4; Pier 8 in Span 5; Bearing 4 at Pier 7 in Span 5.	9 EA
Clean and lubricate bearings.	70 EA

Substructure Repair Recommendations	Quantity
Seal cracks in the concrete substructure.	12 LF
Clean and seal all substructure units with silicone acrylic concrete sealer.	15267 SF
Repair shallow spalls in the concrete substructure.	21 CF
Repair deep spalls in the concrete substructure.	36 CF

Design Recommendations

Deck Design Recommendations	Quantity
Remove joint and install deck continuity pour at Pier E52 and Pier E54.	25 LF
Remove the existing parapets.	76 CY
Construct new parapets.	125 CY
Remove the existing concrete deck.	340 CY
Replace the concrete deck.	340 CY
Install a new 1" PPC overlay.	23 CY

5.4.6 Bridge 1-758F

Repair Recommendations

Deck Repair Recommendations	Quantity
Install joints at Pier F4 (1 ½" strip seals).	26 LF
Install joints at the abutment and Pier F2 (2" strip seals).	52 LF
Install joints at Pier F3 and Pier EF (3" strip seals).	58 LF

Superstructure Repair Recommendations	Quantity
Clean and paint the steel superstructure.	28084 SF
Replace frozen bearing due to pack at Bearing 1 at Pier 1, in Span 2 and at Bearing 4 at Pier 2, in Span 3.	2 EA
Clean and lubricate bearings.	34 EA

Substructure Repair Recommendations	Quantity
Clean and seal all substructure units with silicone acrylic concrete sealer.	9065 SF
Seal cracks in the concrete substructure.	0 LF
Repair shallow spalls in the concrete substructure.	3 CF
Repair deep spalls in the concrete substructure.	0 CF

Design Recommendations

Deck Design Recommendations	Quantity
Remove the existing parapets.	61 CY
Construct new parapets.	100 CY
Remove existing parapets at the U-Wall at the south end.	11 CY
Construct a moment slab on the U-Wall at the south end.	86 CY
Construct new parapets at the moment slab.	17 CY
Remove the existing concrete deck.	248 CY
Replace the concrete deck.	248 CY
Install a new 1" PPC overlay.	28 CY

5.4.7 Bridge 1-758G

Repair Recommendations

Deck Repair Recommendations	Quantity
Install joints at Piers 26F, 27F, 28F, 29F, 31F, and 33F (1 ½" strip seals).	154 LF
Install joints at Piers 30F, 32F, 34F, 35F, and the abutment (2" strip seals).	129 LF

Superstructure Repair Recommendations	Quantity
Grind smooth gouge in bottom flange of Beam 1 in Span 9.	1 EA
Clean and paint the steel superstructure.	30106 SF
Jack and replace misaligned North Abutment bearings in Span 10.	4 EA
Clean and lubricate bearings.	80 EA

Substructure Repair Recommendations	Quantity
Seal cracks in the concrete substructure.	47 LF
Clean and seal all substructure units with silicone acrylic concrete sealer.	22100 SF
Repair shallow spalls in the concrete substructure.	5 CF
Repair deep spalls in the concrete substructure.	30 CF

Design Recommendations

Deck Design Recommendations	Quantity
Remove the existing parapets on BR 1-758G.	132 CY
Construct new parapets on BR 1-758G.	216 CY
Remove existing parapets at U-Wall at north end.	16 CY
Construct a moment slab on the U-Wall at the north end.	129 CY
Construct new parapets at the moment slab.	25 CY
Remove the existing parapets at the at grade portion between BR 1-758F and BR 1-758G.	71 CY
Construct new parapets at the at grade portion between BR 1-758F and BR 1-758G.	116 CY
Remove the existing concrete deck.	496 CY
Replace the concrete deck.	496 CY
Install a new 1" PPC overlay.	55 CY

5.4.8 Bridge 1-758H

Repair Recommendations

Deck Repair Recommendations	Quantity
Replace the joint at the abutment (2" strip seals).	42 LF
Replace the joints at Piers EF1, EF2, EF3, EF4, EF5, and EF6 (3" strip seals).	302 LF
Repair concrete deck (0" to 3 1/2" depth).	2060 SF
Repair concrete deck (3 1/2" to < full-depth).	270 SF
Furnish and install a new LMC overlay.	161 CY

Superstructure Repair Recommendations	Quantity
Clean and paint the steel superstructure.	40806 SF
Remove concrete from Bearing 6 at Pier 3 in Span 3.	1 EA
Clean and lubricate bearings.	92 EA

Substructure Repair Recommendations	Quantity
Seal cracks in the concrete substructure.	17 LF
Clean and seal all substructure units with silicone acrylic concrete sealer.	20761 SF
Repair shallow spalls in the concrete substructure.	16 CF
Repair deep spalls in the concrete substructure.	107 CF
Replace missing anchor at downspout support at the west face of Column 3, at Pier 2.	1 EA

Design Recommendations

Deck Design Recommendations	Quantity
Remove joint and install deck continuity pour at Pier EF7.	42 LF
Remove the existing parapets.	100 CY
Construct new parapets.	164 CY
Remove the concrete deck in the outside bays and overhangs.	168 CY
Remove the deck concrete adjacent to the joints.	51 CY
Replace the deck in the outside bays and overhangs.	168 CY

5.4.9 Bridge 1-744

Monitoring Recommendations

In accordance with the National Bridge Inspection Standards, DelDOT Underwater Bridge Inspection Guidelines, and based on the inspection findings it is recommended that the submerged substructure units of Bridge No. 1-744-059 be placed on an accelerated routine underwater inspection interval of 24 months.

Repair Recommendations

Deck Repair Recommendations	Quantity
Replace the joints at the abutments (1 ½" strip seals).	276 LF
Replace the joints at Piers 1, 3, 5, and 6 (3" strip seals).	552 LF
Remove the deck adjacent to the joints.	185 CY
Furnish and install a new LMC overlay.	363 CY
Mill the existing overlay.	10,994 SYIN
Repair concrete deck (0" to 3 ½" depth).	3,760 SF
Repair concrete deck (3 ½" to < full-depth).	520SF

Superstructure Repair Recommendations	Quantity
Clean and paint the steel superstructure.	103,150 SF
Clean and lubricate the bearings.	224 EA
Replace Bearings 1-16, Span2, Pier 1; Bearing 7, Span 3, Pier 3; Bearings 1 and 13-16, Span 4, Pier 3; Bearing 9, Span 5, Pier 4; Bearings 14-15, Span 5, Pier 5; Bearings 1-16, Span 6, Pier 5; and Bearings 11-12, Span 7, Pier 6.	43 EA

Substructure Repair Recommendations	Quantity
Replace missing riprap at the exposed footing at the south abutment.	5 SY
Remove the debris from the beam seat of the south abutment.	1 EA
Remove cable wrapped around Pier 2 West column.	1 EA
Clean and seal all substructure units with silicone acrylic concrete sealer.	50,684 SF
Repair the erosion and adjacent undermining of the flume at the north abutment.	1 CY
Remove the debris from the beam seat of the north abutment.	1 EA
Repair shallow spalls and areas of delaminated concrete in the substructure.	126 CF
Repair deep spalls in the substructure.	161 CF
Seal cracks in the substructure.	203 LF
Install a fiberglass jacket around each pier stem.	2,184 SF

Design Recommendations

Deck Design Recommendations	Quantity
Remove joint and install deck continuity pour at Piers 2 and 4.	276 LF
Remove the existing parapets.	255 CY
Construct new parapets.	308 CY
Remove the deck concrete in the outside bays and overhangs.	387 CY
Replace the deck in the outside bays and overhangs.	387 CY

5.4.10 Bridge 1-745

Repair Recommendations

Deck Repair Recommendations	Quantity
Replace the joints.	1,332 LF
Furnish and install a new LMC overlay.	299 CY
Mill the existing overlay.	8,579 SYIN
Remove the deck concrete adjacent to the joints.	196 CY
Repair concrete deck (0" to 3 ½" depth).	2,980 SF
Repair concrete deck (3 ½" to < full-depth).	420 SF

Superstructure Repair Recommendations	Quantity
Clean and paint the girders.	82,294 SF
Clean and lubricate the bearings.	192 EA
Replace Bearings 11 and 14, Pier 4, Span 4 and Bearing 8, North Abutment.	3 EA
Repair the section loss at the stiffener at Beam 16, Pier 2, Span 2.	1 EA
Replace the missing bolt on the west side at Pier 4, Span 5, Bearing 13.	1 EA
Tighten the anchor bolts at Bearing 8, Pier 4, Span 4.	1 EA

Substructure Repair Recommendations	Quantity
Repair shallow spalls and areas of delaminated concrete in the substructure.	65 CF
Repair deep spalls in the substructure.	62 CF
Seal cracks in the substructure.	93 LF
Clean and paint the inside and outside of the steel pier caps.	34,257 SF
Repair the erosion at the South Abutment Slope.	3 CY
Repair the erosion at the North Abutment Slope.	24 CY
Repair the broken and inaccessible access grates on the pier caps.	7 EA
Repair the loose bolts at the diaphragms in Pier Caps 1, 3, and 5.	12 EA
Replace the missing bolts at Pier 5, Bay 10 and Pier 3 Cap, Bay 9.	2 EA
Repair the section loss at the stiffeners at the south face of the Pier 2 and Pier 4 Caps.	2 EA
Repair the section loss at the bearing stiffener at the center column of Pier 1 Cap, North Face.	1 EA
Repair the misaligned bolt at the east diaphragm at the Pier 3 Cap, Bay 7.	1 EA
Repair the buckled stiffeners at the Pier 4 Cap.	3 EA

Substructure Repair Recommendations	Quantity
Repair the disconnected and clogged drain pipe at Column 1, Pier 4.	1 EA
Clean and seal all substructure units with silicone acrylic concrete sealer.	24,805 SF
Repair the missing welds at Pier 4 Cap, Bay 13.	6 LF

Design Recommendations

Deck Design Recommendations	Quantity
Remove the existing parapets.	210 CY
Construct new parapets.	254 CY
Replace the barrier on the parapets over the railroad.	170 LF
Remove the deck concrete in the outside bays and overhangs.	324 CY
Replace the deck in the outside bays and overhangs.	324 CY

5.4.11 Bridge 1-746

Repair Recommendations

Deck Repair Recommendations	Quantity
Replace the joints at the abutments (1 ½" strip seals).	226 LF
Replace the joints at Piers 1 and 2 (3" strip seals).	226 LF
Mill the existing overlay.	4032 SYIN
Furnish and install a new LMC overlay.	135 CY
Repair spalls on deck underside.	4 CF
Repair concrete deck (0" to 3 ½" depth).	1,380 SF
Repair concrete deck (3 ½" to < full-depth).	200 SF

Superstructure Repair Recommendations	Quantity
Clean and paint the steel superstructure.	34257 SF
Clean and lubricate bearings.	96 EA
Tighten the anchor nuts at Bearings.	4 EA

Substructure Repair Recommendations	Quantity
Repair the scour holes at Pier 2.	500 SF
Repair deep spalls in the substructure.	4 CF
Seal cracks in the substructure.	100 LF
Repair shallow spalls and areas of delaminated concrete in the substructure.	50 CF
Clean and seal all substructure units with silicone acrylic concrete sealer.	8361 SF

Design Recommendations

Deck Design Recommendations	Quantity
Remove the existing parapets.	95 CY
Construct new parapets.	115 CY
Remove the deck concrete in the outside bays and overhangs.	152 CY
Replace the deck at the outside bays and overhangs.	152 CY

6.0 Cost Summary

Based on the recommended repair recommendations listed previously, WRA has compiled a conceptual construction cost estimate for the project. While no design computations or detailed quantities have been calculated for the various repair or design recommendations at this stage, a sufficient order of magnitude cost investigation has been completed for critical repair items. In addition, contingent quantities have been assigned to the various repair items to account for unforeseen or variable field conditions or as a result of a change in the condition of the bridge between now and 2019. Unit prices have been assigned to the various repair items and were based off of DelDOT bid tabs for similar rehabilitation projects and/or similar bridge rehabilitation projects recently completed by other agencies that are located within the region in urban environments. All costs provided are for current year and have not been inflated for the future.

In addition to the project unit costs for the repairs, costs are provided for the typical major lump sum items. Until final design is completed, these costs have been estimated based on the following assumed percentages of the overall repair item costs:

- | | |
|---|------|
| • Initial Expense | 8% |
| • Construction Engineering | 1% |
| • Project Control System Development Plan | 0.1% |
| • Maintenance of Traffic, All Inclusive | 6% |

Costs for new cantilever and overhead sign structures to be installed onto the project bridges have been included as well as a cost for the reconstruction of the I-95 pavement north and south of the Wilmington Viaduct. These costs include provisions for excavation and pavement reconstruction with 2" Type C WMA/4" Type B WMA/6" BCBC/12" GABC, reconstruction of PCC median barrier and steel guardrail along the outside shoulders, RPM, lane striping, rumble strips, and drainage.

The total project cost for the Wilmington Viaduct and associated project mainline bridges and ramps is \$111,000,000. This cost includes a 30% contingency which also accounts for the proposed bridge and underbridge lighting, erosion and sediment control, drainage system improvements, and the various miscellaneous repair recommendations that are not specifically quantified in the estimate for each project bridge (due to their relatively small quantity). A breakdown for each project bridge is provided in Table 6.1 on the following page and is followed by an itemized cost estimate for each bridge including estimated quantities and prices.

Bridge	Estimated Construction Cost
1-748, 1-748N, & 1-748S	\$44,164,380
1-749	\$2,108,443
1-750	\$601,531
1-758	\$1,708,212
1-758E	\$1,633,321
1-758F	\$1,549,761
1-758G	\$2,724,953
1-758H	\$1,846,023
1-744	\$5,070,244
1-745	\$4,651,961
1-746	\$1,741,332

Table 6.1 – Bridge by bridge cost estimate